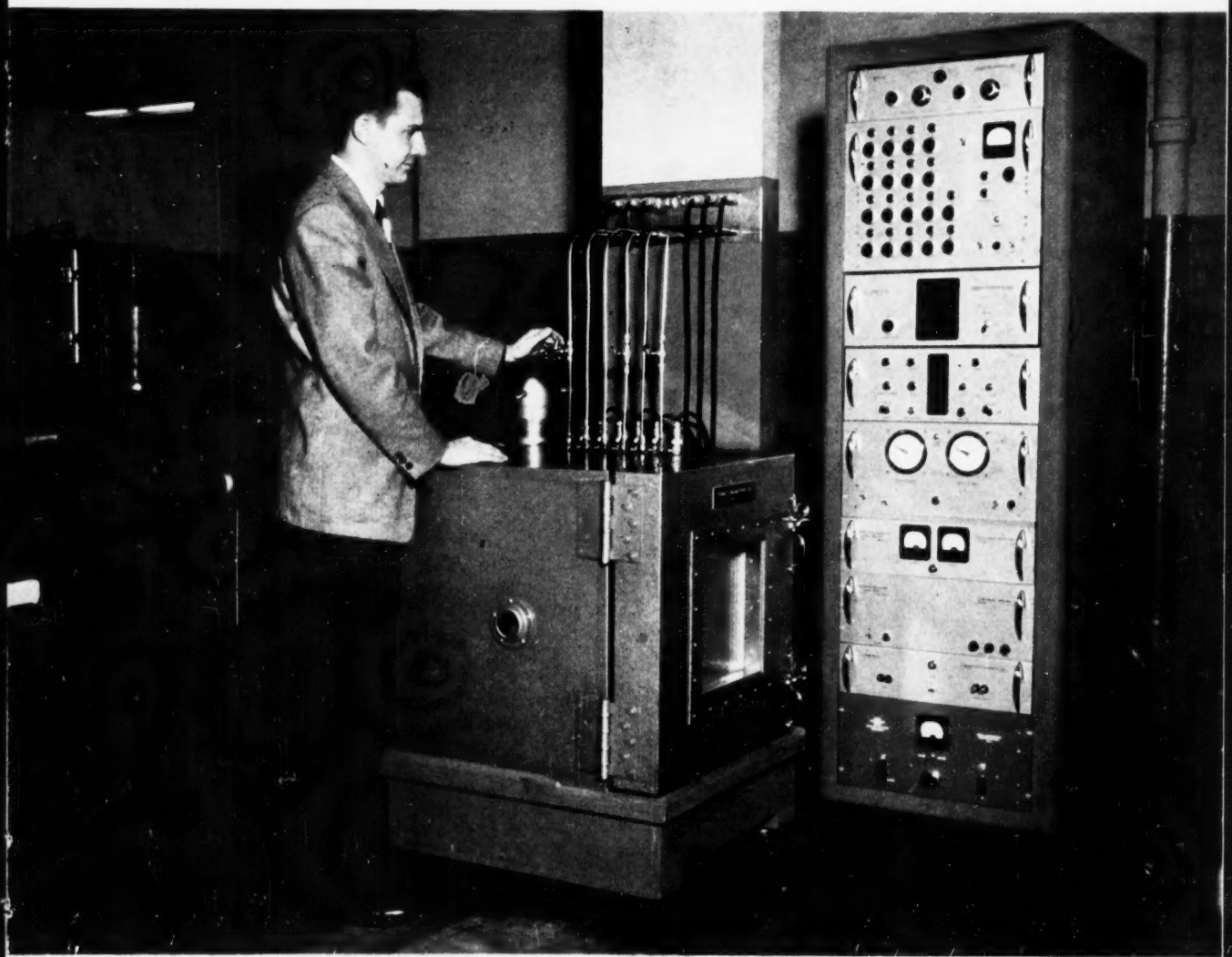
Instruments

THE MAGAZINE OF MEASUREMENT
INSPECTION · TESTING · CONTROL



Automatic calibration of pickups at plant of Consolidated Engineering Corp., Pasadena, Calif.
(Photo Courtesy Crawford Fitting Co. For story see page 1526)

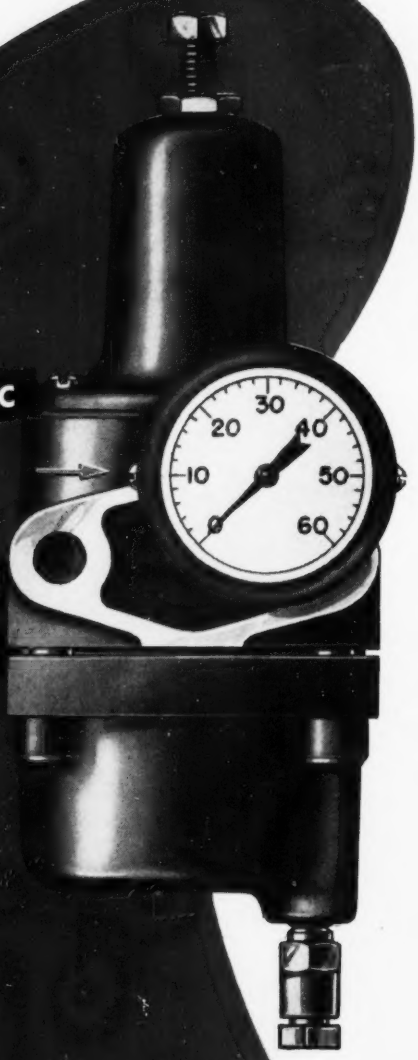
Including the
JOURNAL OF THE INSTRUMENT SOCIETY OF AMERICA (Page 1531)

and the
JOURNAL OF THE SOUTHERN CALIFORNIA METER ASSOCIATION (Page 1543)

Vol. 26 No. 10
OCTOBER • 1953

FISHER®

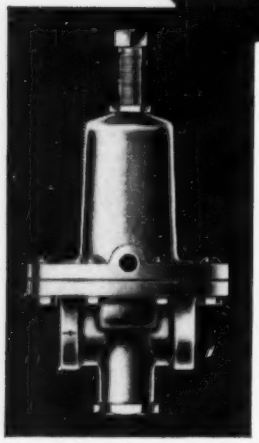
SMALL VOLUME REGULATORS



TYPE 67FRTC

A "PACKAGED UNIT" — REGULATOR FILTER and PRESSURE GAUGE

Fisher Series 67 and 67FR Regulators have won universal acceptance for small volume air or gas flows. They are used for hundreds of industrial applications and are particularly adapted to instrument air service, supplying 20 psi operating medium pressure to pilot operated regulators. Capacity up to 6 C. F. M. Outlet pressure ranges 0 to 100 pounds depending on spring selected. Gauge ranges to correspond. ¼" inlet and outlet. For further details and complete specifications, write for Bulletin 67.



TYPE 64

MASTER INSTRUMENT AIR REGULATOR

Type 64 is especially suited as a reducing regulator to maintain a constant operating medium feeding a manifold line to several pilot operated controllers or instruments. The high capacity of this regulator eliminates the need for an instrument air regulator for each pilot.

SIZE ½" inlet and outlet. Pressure ranges: Maximum inlet — 250 psi at 150° F. Reduced 3 to 60 psi. Maximum capacity: 30 C. F. M.

WRITE FOR BULLETIN C-64

TYPE 67

with handwheel adjusting screw. Also available as Type 67P for panel mounting.

FISHER GOVERNOR COMPANY • Marshalltown, Iowa

LEADS THE INDUSTRY IN RESEARCH FOR BETTER PRESSURE CONTROL

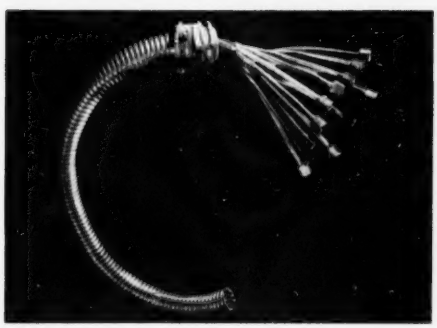
FISHER Since 1880

For more information circle 1 on inquiry card.

For the new pneumatic instrumentation

Cabled Tube

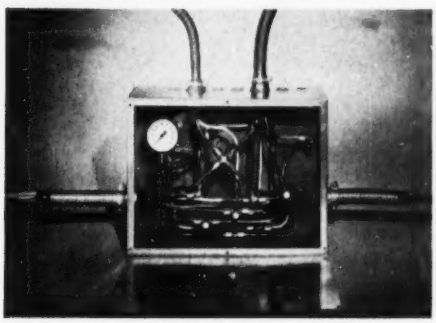
The recent tremendous increase in the use of tube instead of wires for instrumentation and control purposes has led to an important new development—cabled tube. This is an armored group of long tubes twisted together to permit bending without distortion. An insulating tape is wrapped over the bundle of tubes to prevent electrolytic action. Then interlocking, flexible galvanized steel armor is applied, like BX. This protects the tubes from injury during shipment, storage, installation, and in service. Standard fittings, boxes and cabinets can be used for junction boxes and terminations. To make it possible to readily identify each tube, one tube in each layer is colored; the position of each tube in each layer in relation to the coded tube



remains the same throughout the length of the cable.

The tubes usually are copper, but aluminum tubes can be used for special purposes. For unusually corrosive situations, a plastic outer sheath can be applied. As many as 19 tubes, ¼" OD, can be cabled, and supplied in lengths up to 1,000 ft.

Since the tubes carry not electricity but air, nitrogen, helium, or a fluid, they are especially attractive in potentially explosive locations, as in refineries and chemical plants. Utilities are also turning decisively to this new cable, while automatic process control (automation) is a rising application.



Revere, as a supplier of tube for this purpose, calls this cabled tube development to your attention as a matter of general and perhaps specific interest. See Revere for copper, aluminum and brass tube and pipe, electric welded steel tube, and lockseam tube. Call the nearest Sales Office.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y. Sales Offices in Principal Cities, Distributors Everywhere

SEE "MEET THE PRESS" ON NBC TELEVISION, SUNDAYS

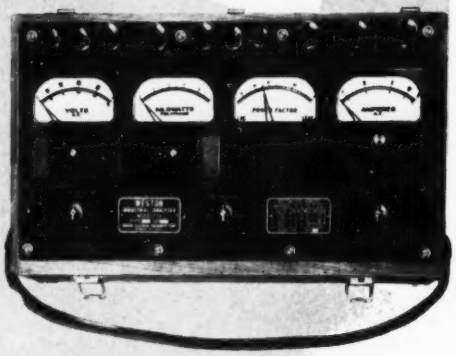
Showing the construction of Crescent Armored Multitube, made by Crescent Insulated Wire and Cable Co., Trenton 5, N. J., which will supply further information on request.

For more information circle **2** on inquiry card.

tools that Streamline electrical maintenance

FOR POWER PROBLEMS...

FOR MOTORIZED EQUIPMENT...



FOR ELECTRONIC TROUBLE SHOOTING...

WESTON A-C INDUSTRIAL ANALYZER
(Model 639) a combined Voltmeter, Wattmeter, Power Factor Meter, Ammeter . . . all interconnections made!

A real timesaver because only one hook-up is necessary to measure a-c current, voltage and power in single and polyphase circuits, as well as power factor in 3 phase, 3 wire, balanced circuits. Adequately insulated binding posts . . . high overload capacity. Furnished in compact oak carrying case measuring only 18⅞" x10⅞"x6⅞".

WESTON INDUSTRIAL CIRCUIT TESTER
(Model 785) the versatile 28 range super-sensitive portable tester.

Especially designed for checking electronic control and power equipment. Seven d-c voltage ranges: .1 to 1000 (20,000 ohms per volt) . . . six a-c voltage ranges: 5 to 750 (1000 ohms per volt) . . . six d-c current ranges: 50 microamperes to 10 amperes . . . four a-c current ranges: .5 to 10 amperes . . . five resistance ranges: 3000 ohms to 30 megohms . . . all ranges full scale . . . a-c and d-c current ranges extended with external transformer or shunts. New temperature compensated rectifier circuit gives greater a-c accuracy.

WESTON CLAMP VOLT-AMMETER
(Model 633) measures current and voltage without breaking circuits and disrupting operations.

Combines in one instrument five full-scale a-c current ranges of 1000/250/100/25/10 amperes with range overlap for good readability . . . three self-contained a-c voltage ranges of 700/350/-175 volts, with instrument insulated for 750 volt service. Has convenient 6-position thumb switch for range selection, and adjustable pointer stop for measuring motor starting current.

AVAILABLE THROUGH LEADING DISTRIBUTORS

WESTON *Instruments*

WESTON Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

For more information circle **3** on Inquiry card.

For more information circle **4**

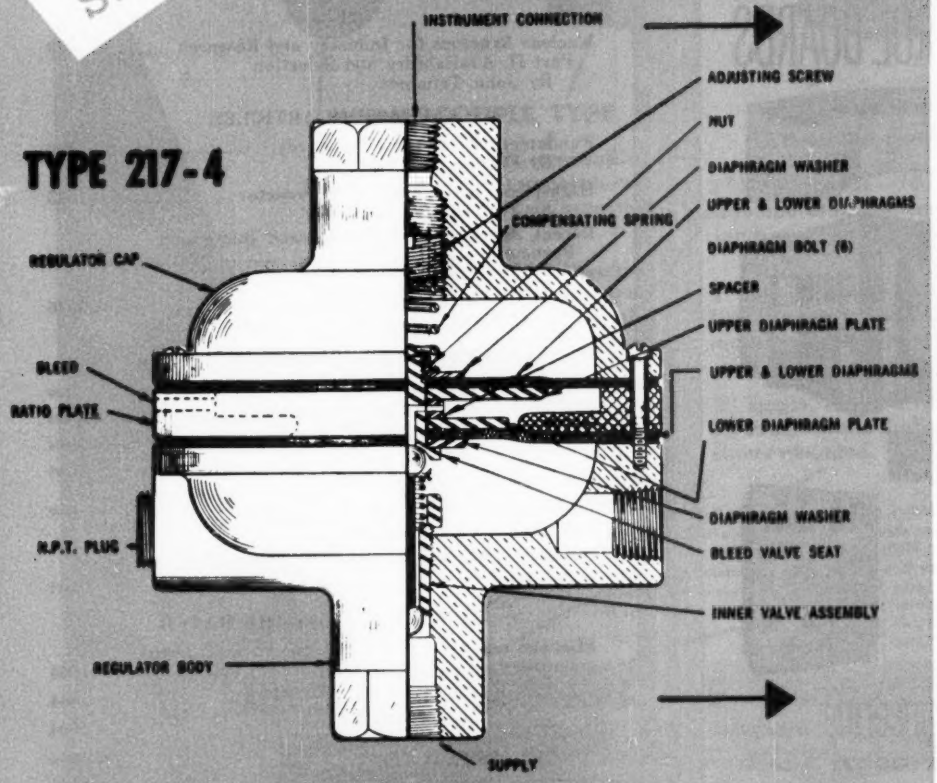
STEP-UP

SPEED-UP

SLOW-UP

VALVE ACTION *with* BS&B CLIMAX RELAYS

TYPE 217-4



For almost any pressure, input or output variation in the supply medium to the control valve, there's a Climax Relay to do the job efficiently and accurately. You can deliver pressure output to step up action, boost the capacity of low-limit controls to handle larger loads, speed the valve loading or reduce it, eliminate pressure lag on long supply medium lines, control high steam pressures with balanced diaphragm regulators.

New BS&B Climax Relays are being constantly developed to meet the demands of the latest methods and equipment. Their accuracy and sensitivity will contribute much to the efficiency of your processing system. They will, in many cases, provide a great economy by permitting your valves and controls to expand their designed functions.

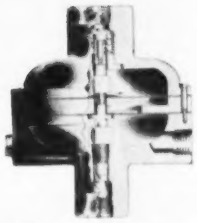
Write for Catalog Section 109—"Relay Regulators." Illustrated, complete with descriptions, application and installation data.

CLIMAX BS&B CONTROLS

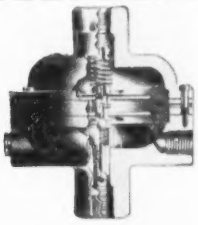
BLACK, SIVALLS & BRYSON, INC.

Climax Controls Division Dept. 4-V10

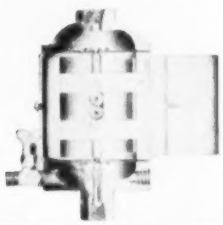
7500 East 12th St. Kansas City 3, Mo.



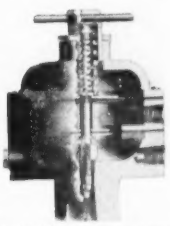
NEW TYPE 227 Delayed action, fixed ratio. Permits full valve travel with standard diaphragm pressure ranges on series-operating diaphragm control valves in combination with type 217-2B relay.



TYPE 217 Fixed Ratio—to meet demands of control pressures beyond the range of usual instrument pressures; permits low-limit controls to secure higher loading pressure.



TYPE 224 Variable Ratio—creates a loading of pressure balanced diaphragm valves to permit the control of high steam pressures in reboilers or fractionating kettles, where steam pressures must vary for varying products.



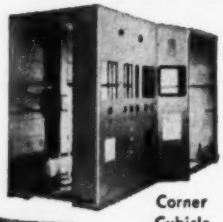
NEW TYPE 225 Reverse Action Relay for maximum pressure output at minimum input—or vice versa. Or, in by-pass installation, reverse valve action in relation to pilot action, when occasionally required.

TYPE 209 1 to 1 Ratio—will eliminate air exhaust and input pressure lag where long supply medium lines are used.

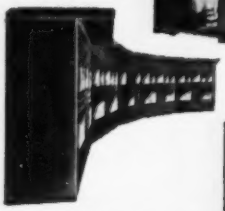
Quality is assured with
FALSTROM

INSTRUMENT PANELS
and CONTROL BOARDS

Benchboard Console



Five Section Cubicle Control Board and Lighting Canopy



Corner Cubicle Section

Refinery Cubicle with Mimic Flow Diagram in Color

Superior Engineering MAKES
FALSTROM YOUR LOGICAL CHOICE!

Experienced designing and quality fabrication assure the efficiency of any indicating, recording, or control installation. Whether you are planning new construction, modernizing existing installations or adding to present equipment, FALSTROM offers long years of experience and the most modern facilities for fabricating to your specifications or recommending standard designs. In any case, by specifying FALSTROM you specify the highest possible quality metal working techniques known to the industry. Estimates on your needs will be supplied promptly—call or write FALSTROM to arrange a consultation.

WRITE FOR BULLETIN #125

SINCE 1870 FALSTROM COMPANY
92 Falstrom Court, Passaic, New Jersey
DESIGNERS, ENGINEERS AND BUILDERS OF CUSTOM METAL PRODUCTS FOR INDUSTRY

For more information circle 5 on inquiry card.

Instruments
THE MAGAZINE OF MEASUREMENT INSPECTION · TESTING · CONTROL

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LEWIS TEMPERATURE INDICATORS FOR AIRCRAFT

TO AIR FORCE SPECIFICATIONS

THERMOCOUPLE TYPE

2" Single shown with removable Bezel. For exhaust temperature, range 0 to 1000°C, Chromel-Alumel.

2¾" Dual shown with removable Bezel. For exhaust temperature range 0 to 1000°C, Chromel-Alumel.

2" Single, for ring clamp mounting. For cylinder temperature, range −50 to +300°C, Iron-Constantan.

RESISTANCE TYPE

12 or 24 volt ratiometers

2" Single, range −70 to +150°C oil temperature indicator, for ring clamp mounting.

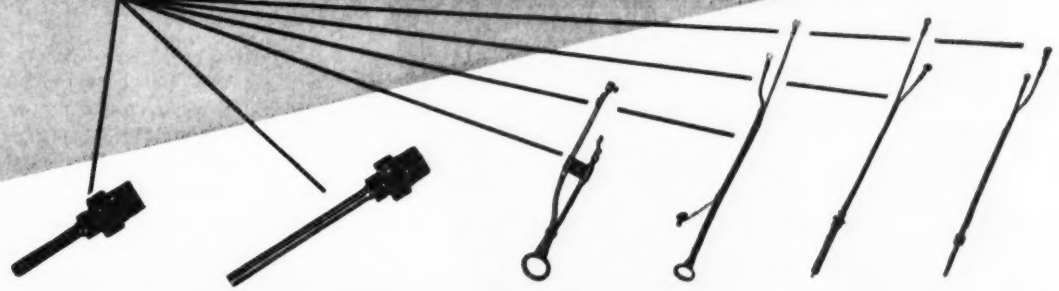
2" Single, range −50 to 50°C for carburetor-air temperature indication, ring-clamp mounted.

2" Single, range 0 to 190°C for oil temperature indication, ring clamp mounted.

Available in all standard ranges for cylinder head, bearing carburetor-air, coolant, oil, free-air and heating-duct temperatures. For best results, use LEWIS resistance bulbs as sensing elements with LEWIS instruments. Any of above instruments may be supplied with type A-1 bezel if specified.

AIRCRAFT RESISTANCE BULBS AND THERMOCOUPLES

FOR BEST RESULTS USE LEWIS INSTRUMENTS WITH LEWIS BULBS AND THERMOCOUPLES



STANDARD AN5525-1 with 1⅞ in. stem

STANDARD AN5525-2 with 4 in. stem

AN5540-1

AN5540-2

AN5545-1

AN5541-1

In addition to the standard "AN" Types illustrated, we manufacture thermocouples for test work as well as special types to customer's specifications.

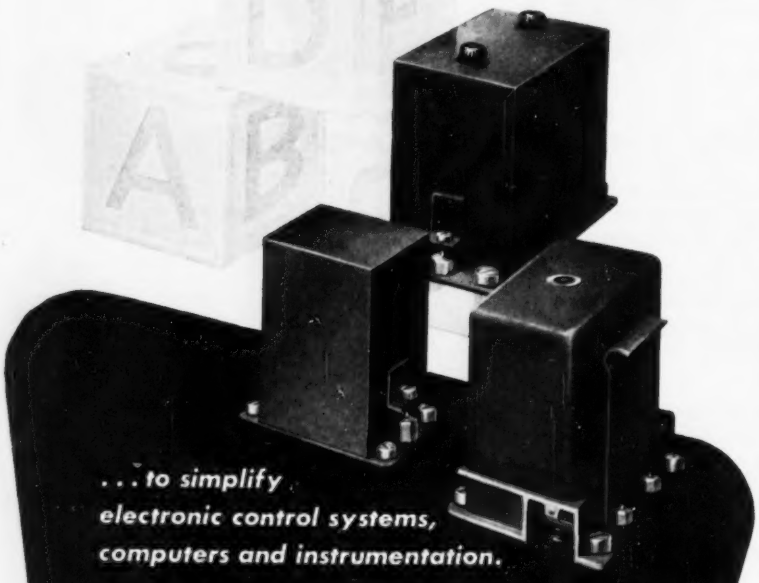
THE LEWIS ENGINEERING CO.

Manufacturers of *Complete* Temperature Measuring Systems for Aircraft

NAUGATUCK, CONNECTICUT

For more information circle ♦ on inquiry card.

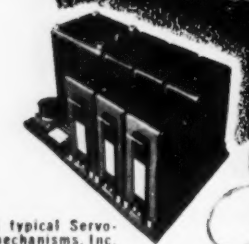
Electronic BUILDING BLOCKS



. . . to simplify electronic control systems, computers and instrumentation.

Servomechanisms, Inc. "building block" or packaged function technique reduces intricate "all in one" systems into simple, standard electronic components which plug into pre-wired chassis. This advanced design philosophy provides ***reliability, interchangeability, and ease of maintenance.***

The same concept has been applied to Servomechanisms, Inc. expanding line of transducers.



Universally accepted and proven in combat these "building blocks" are available for 60 and 400 cycle applications. Write to Dept. CLO-4 for complete information.

A typical Servomechanisms, Inc. analog computer and transducer for aircraft instrumentation.

SERVOmechaNISMS INC.

Westbury Division
Post and Stewart Aves., Westbury, N. Y.

El Segundo Division
316 Washington St., El Segundo, Calif.

POSITIONING MECHANISMS • SERVO AMPLIFIERS • MODULATORS • POWER SUPPLIES
SERVO MOTORS • ADAPTERS • TRANSDUCERS • MECHANICAL DEVELOPMENT APPARATUS

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Instruments

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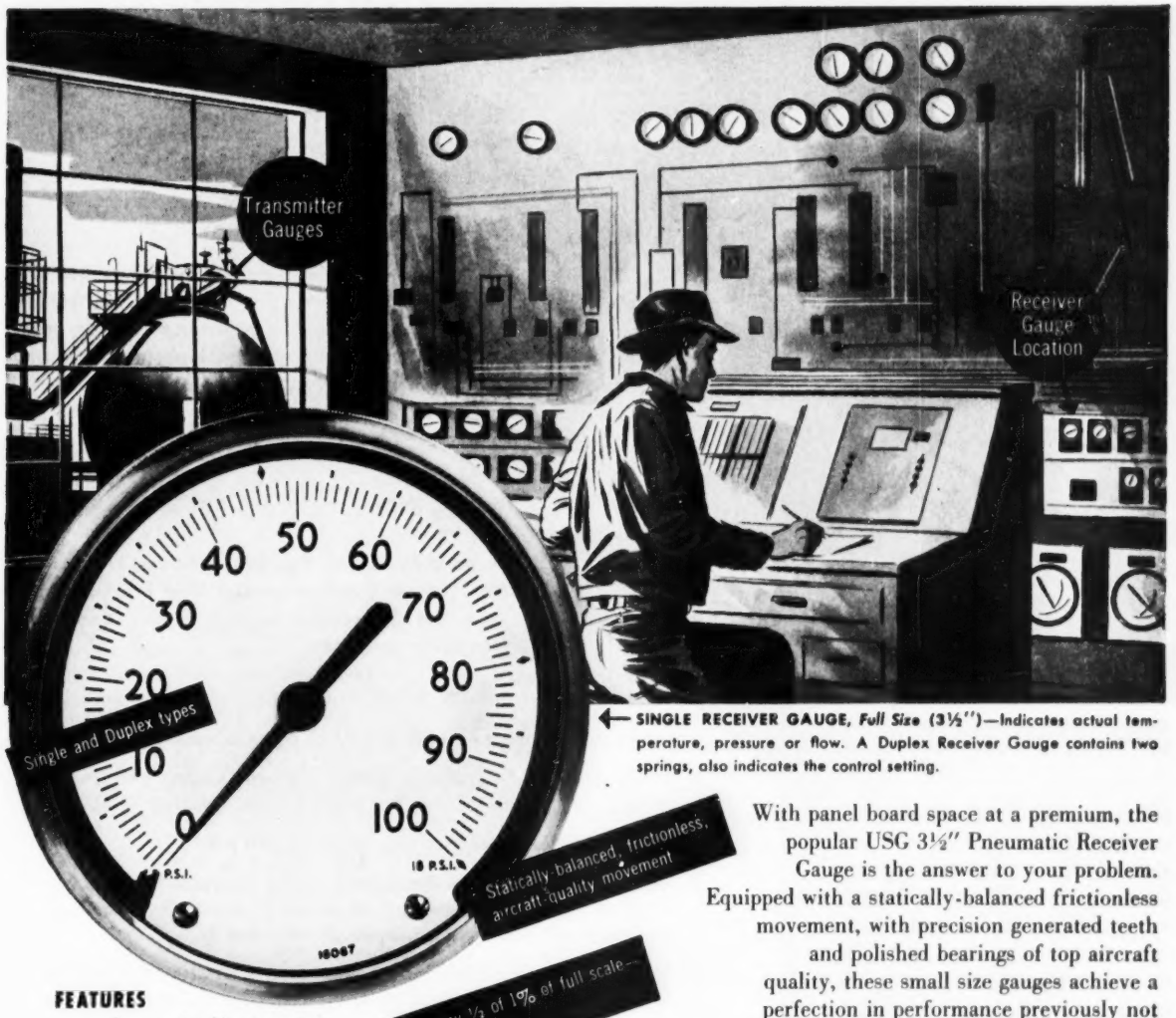
Read pressure, temperature or flow at a distance with USG Pneumatic Receiver Gauges



← **SINGLE RECEIVER GAUGE, *Full Size* (3½")**—Indicates actual temperature, pressure or flow. A Duplex Receiver Gauge contains two springs, also indicates the control setting.

With panel board space at a premium, the popular USG 3½" Pneumatic Receiver Gauge is the answer to your problem. Equipped with a statically-balanced frictionless movement, with precision generated teeth and polished bearings of top aircraft quality, these small size gauges achieve a perfection in performance previously not thought possible of a pressure gauge.

FEATURES

Ranges:	3 to 15 p.s.i.g. stocked, 3-18 p.s.i.g. also available.
Scale:	A variety of scales available.
Case Diam.:	3¾"
Bezel Opening:	3½"
Pressure Elements:	Phosphor Bronze, AAA width, stress-relieved.
Movement:	Aircraft quality — phosphor bronze and stainless steel.
Adjustments:	±1% maximum linearity adjustment with adjustable tip; micro-adjustable pointer permits rotation with respect to pinion for zero adjustment.
Stops:	Zero and over-range.
Case:	Drawn steel, black crinkled finish, bevelled glass.
Socket:	Extruded brass.

SINGLE OR DUPLEX TYPES—The USG Receiver Gauge is graduated to the same scale as the transmitter gauge yet operates at a very small pilot pressure. It is available with a single spring or double spring (Duplex Receiver Gauge).

GAUGES CARRIED IN STOCK—USG Receiver Gauges are stocked without dials in the range of 3-15 lbs. This permits easy assembly and quick shipment of gauges with dials calibrated to your choosing. Single-spring gauges are available in ¼" low male or center back connection. Duplex gauges are available in low back connection with ⅛" or ¼" male pipe thread and 5/16-28 tubing connection.

United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Pa.

UNITED STATES GAUGE

Quality Gauges Engineered for Enduring Accuracy

PRODUCTS OF UNITED STATES GAUGE... Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude-Gauges • Boiler Gauges • Chemical Gauges • Mercury, Gas, and Vapor Dial Thermometers • Glass Tube and Industrial Thermometers • Flow Meters • Inspectors' Test Gauges • Precision Laboratory Test Gauges • Marine, Ship and Air-Brake Gauges • Voltmeters • Ammeters • Welding Gauges

OTHER DIVISIONS OF AMERICAN MACHINE AND METALS, INC., AT SELLERSVILLE, PA.:
GOTHAM INSTRUMENTS AND AUTOBAR SYSTEMS

For more information circle **8** on inquiry card.

SR-4® DEVICES IN INDUSTRY... USES UNLIMITED

THE PROBLEM:

In the static testing of rocket fuel systems, Aberdeen Proving Ground needed a transducer which could respond to the high pressures and frequencies encountered.

THE BALDWIN SOLUTION:

To meet this need, Baldwin designed and manufactured one hundred special SR-4 Pressure Cells with the necessary high accuracy and high frequency response.

20,000 p.s.i. high frequency pressure cell. Length-3½", diameter 2", weight-1 lb.

These transducers give Aberdeen all of these advantages:

1. **High Accuracy**—pressure versus voltage outputs are linear with ¼ of 1% and calibration (span) is held within ½ of 1%.
2. **High Pressures**—capacities up to 20,000 psi.
3. **Limitless Frequency Response**—The frequency response limit of the attached piping or vessel is reached before the pressure cell reaches its frequency response limit.
4. **Versatility**—these SR-4 Pressure Cells are all interchangeable so that they may work into the same instruments. Being electric they also work easily into an oscilloscope which is necessary for high frequency pressure fluctuations. They can be used to operate any null-balancing or manual type potentiometer.

The uses for Baldwin SR-4 devices in industry are unlimited . . . measuring load, pressure or torque more accurately and economically. Wide range of standard capacities available. For the latest technical information please write Dept. 3215, Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

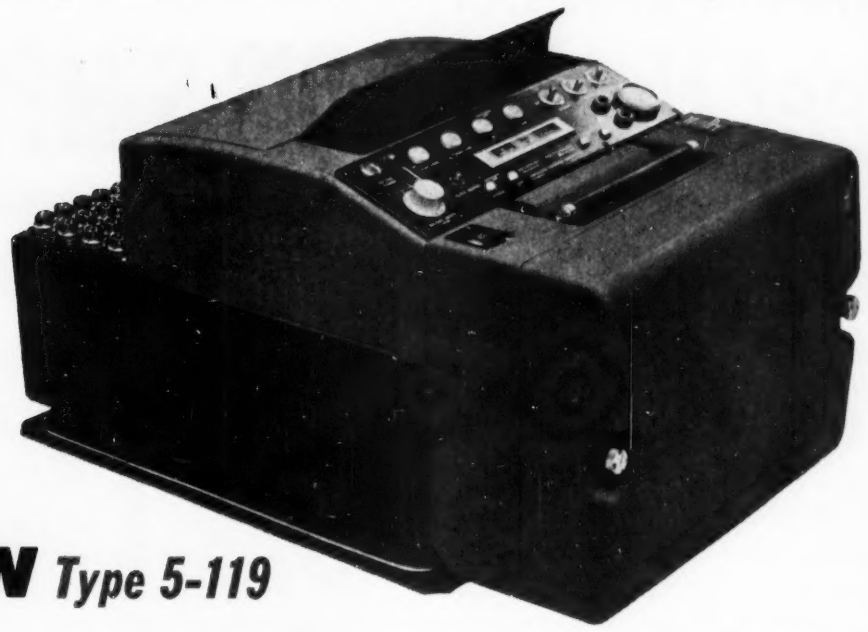
TESTING HEADQUARTERS

BALDWIN-LIMA-HAMILTON

Philadelphia 42, Pa. • Offices in Principal Cities

For more information circle 9 on inquiry card.

YOU *helped create this superior Recording Oscillograph*



NEW *Type 5-119*

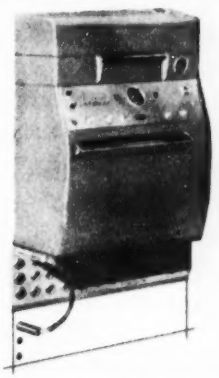
CONSOLIDATED'S new Type 5-119 Oscillograph was designed and built to customer specifications. Many major users were interviewed by our design engineers to determine the features desired in a "perfect" instrument. Foremost demand was for great dependability. Second need indicated was for high trace capacity.

Dependability is achieved by extensive warning and test circuits and by reserve lamps which assure continuous recording in the event of lamp burn-out. Indicators warn immediately of any condition which could cause data loss, while additional circuits permit quick testing of the warning system. Design of the instrument assures reliable operation under the most rigorous environmental conditions.

Standard models provide either 36 or 50 traces. Consolidated's new Series 7-300 Galvanometers provide frequency response flat to 3000 cps. Standard record width of 12" greatly simplifies record interpretation. Only after several prototypes were successfully tested under actual field conditions did we go into production on the 5-119—the new recording oscillograph leader. Write for Bulletin CEC 1536-X6.

SPECIFICATIONS

TRACE CAPACITY	36 or 50-trace models available
TRACE IDENTIFICATION	repeated, sequential trace breaks
RECORD WIDTH	12" standard; narrower widths adaptable
RECORD MAGAZINE	removable, integral type; holds 250′ paper or film
RECORD SPEEDS	0.10 to 100 inches per sec. through quick-change gears, instantaneous switch-actuated, 10:1 speed jump
SCANNING SYSTEM	ground-glass screen and adjustable motor-driven polygon mirror; timing lines show on viewing screen
REMOTE OPERATION	accessory control unit with all essential controls & indicators
TIMING PROVISIONS	0.10 and/or 0.01 sec. lines photographed across record
EVENT NUMBERING	high-speed flash system operates as rapidly as one number per sec.
POWER REQUIREMENTS	115 volt, 60 cycle and 26 volt d-c models
INPUT PROVISIONS	all connectors on one rear deck; individual galvanometer plugs
CONTROL PANEL	all controls and indicators on single panel
ACCESSIBILITY	all adjustments can be made from one surface



The 5-119 can be panel mounted vertically with special shockmounts.

Consolidated Engineering

CORPORATION

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, New York, Chicago, Washington, D. C., Philadelphia, Dallas.*

analytical instruments for science and industry

Recording Oscillographs

The Type 5-119 is the newest of 7 Consolidated Oscillographs ranging from 9 to 50 channel capacity. These versatile instruments simultaneously record any physical phenomena that can be transformed into electrical impulses. All measurements are obtained in clear, permanent form during the same operational cycle for future detailed analysis.

For more information circle **10** on inquiry card.

WHAT'S NEW AT BRISTOL...

Meet the WORLD'S SIMPLEST

It's Bristol's new METAGRAPHIC Pneumatic

for measuring, indicating, recording and controlling pressure, temperature, vacuum, flow, differential pressure, and liquid level

Here are a few of the advantages of Bristol's METAGRAPHIC system:

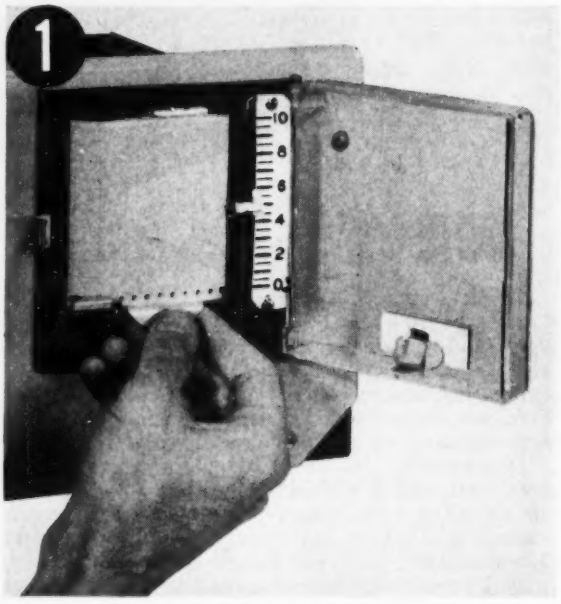
SIMPLICITY... fewer moving parts, fewer adjustments needed, and less service required. Range changes can be made in seconds.

FLEXIBILITY... all components are interchangeable. Units can be combined like building blocks to make up any kind of arrangement; functions can be located exactly where they're needed.

TRUE PLUG-IN SERVICE... provides great savings in installation costs. And if trouble is suspected with any component, just pull the doubtful unit out and plug in a stand-by—*without stopping any processing.* The suspected unit can be taken to the shop and checked whenever time permits. You don't lose any air pressure when changing units, either. Bristol's automatic sealing system prevents loss of signal to other components.

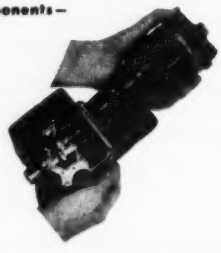
NO TIME LAGS... in a four-pipe circuit the transmitter signal and the controller-output signal travel around a very short loop—which can be as little as three feet long.

These are some of the important advantages of Bristol's METAGRAPHIC instrument system—the product of over 60 years of experience in instrument making and application in practically every industry. Get the whole story by writing to The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.



IT TAKES ONLY SECONDS to change the Bristol METAGRAPHIC receiver from a recorder to an indicator: Case door is opened...

Here are the basic components—



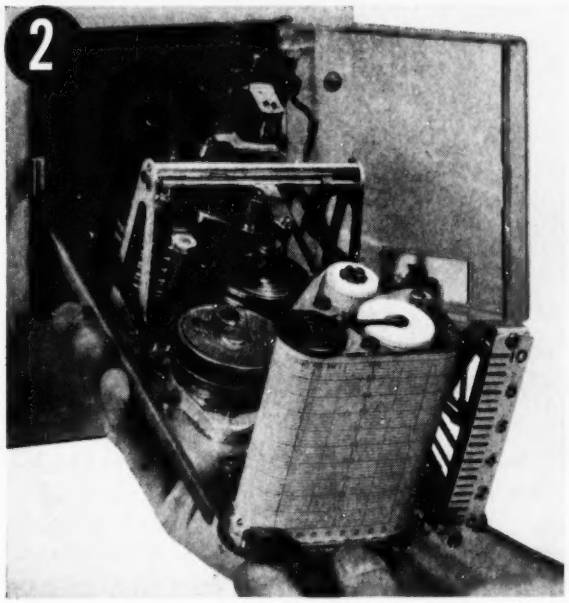
BRISTOL PNEUMATIC TRANSMITTER, with cover removed to show simplicity of the world-famous Bristol measuring element. The frictionless transmitter, with only one pivot and no flexures, will operate in any position, indoors or out. The unit is sensitive to extremely small changes in the measured quantity, as minute as 0.03% of range, including reversal.

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

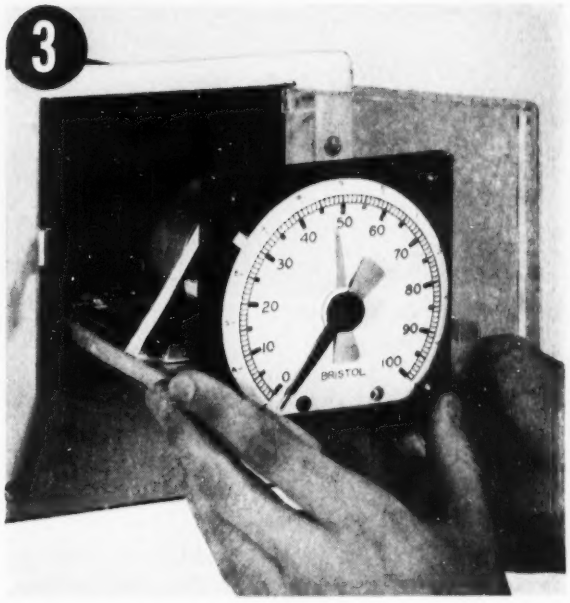
For more information circle **11** on inquiry card.

INSTRUMENT SYSTEM!

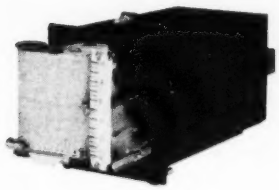
Transmission instrument system . . .



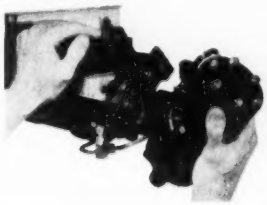
Recorder chassis withdrawn from case (air pressure is automatically maintained) . . .



Indicator chassis is plugged into same case. Control remains undisturbed throughout change-over.



HERE'S THE RECORDER CHASSIS, in retracted position. Now pen can be inked, set point and zero adjustment made without disturbing record or control. You can bring up to three related variables, such as flow, pressure and temperature, into one receiver. Auto-manual switching is foolproof and "bumpless," without disturbing valve position.



THE BRISTOL CONTROLLER can be plugged into back of receiver, placed at process, or used as a "blind controller." Available in on-off, proportional, proportional plus reset, proportional plus derivative, and proportional plus reset plus derivative. Experienced instrument men will recognize this as a unit service-proved by thousands of installations.*

*Licensed under C. B. Moore patents

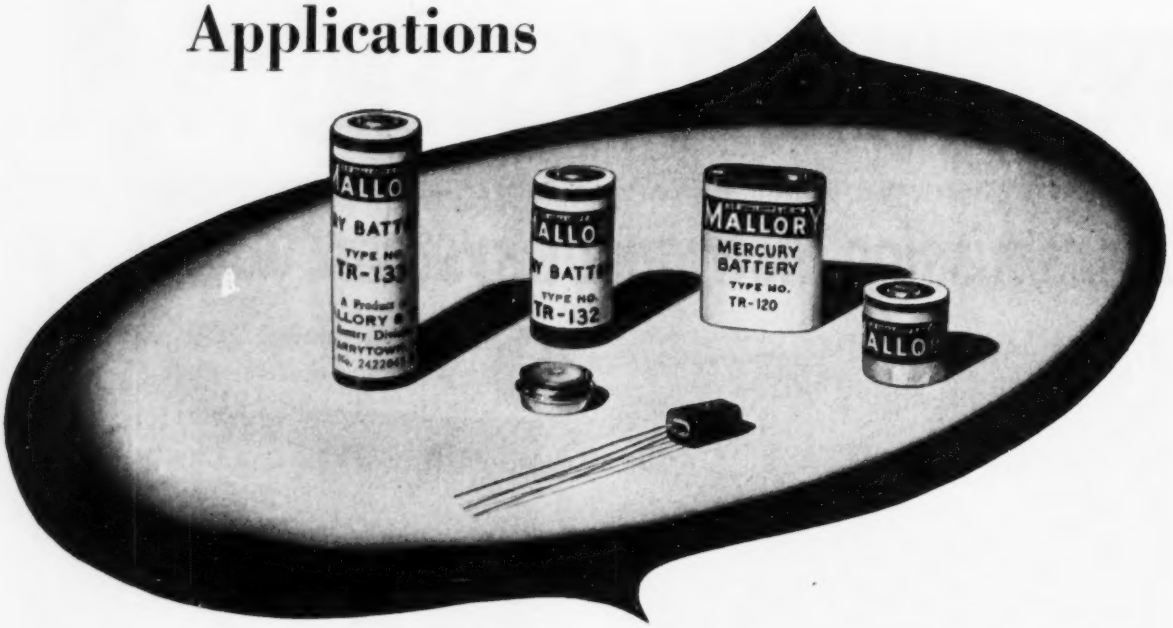
LOOK FOR OUTSTANDING NEW DEVELOPMENTS FROM BRISTOL

BRISTOL

THE DEPENDABLE GUIDEPOST OF INDUSTRY

For more information circle **11** on inquiry card.

For Transistor Applications



Mallory Mercury Batteries provide a constant voltage power supply

Mallory Mercury Batteries are especially well suited for transistor power requirements. They deliver constant voltage and constant current . . . an absolute necessity for the best performance of transistor circuits. In addition, they will not deteriorate or lose their energy during long periods of storage . . . even under the most adverse climatic conditions. Their high ratio of energy to size and weight permits miniaturization of electronic equipment.

New transistor hearing aids are a good example of the substantial size reduction and operating economy that can be accomplished by using Mallory Mercury Batteries and tiny new Mallory Capacitors.

If you are designing equipment around transistor circuits, our engineers will be glad to work with you in selecting a power supply to meet your requirements. Multi-cell packs and stacks are available for applications requiring greater capacity or higher voltages than provided by a single cell. Various combinations can be built for virtually any capacity or space requirement. Write us today for more information.

Use Mallory Mercury Batteries for applications where:

- Constant voltage or current is required
- Size and weight are important
- Long storage periods are involved
- Battery leakage cannot be tolerated
- Wide temperature and pressure ranges are encountered
- Severe impact and shock are expected

P.R. MALLORY & CO. Inc.
MALLORY

SERVING INDUSTRY WITH THESE PRODUCTS:
Electromechanical — Resistors • Switches • Television Tuners • Vibrators
Electrochemical — Capacitors • Rectifiers • Mercury Batteries
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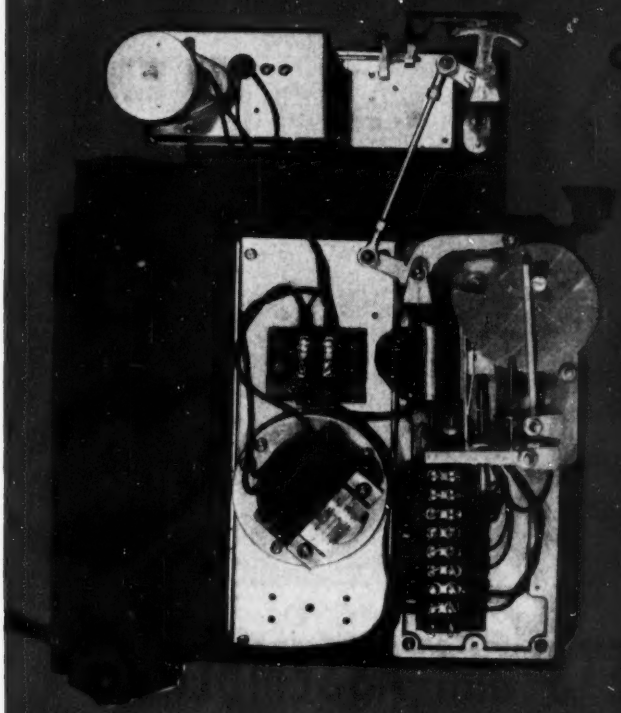
P. R. MALLORY & CO. INC., BATTERY DIVISION, NORTH TARRYTOWN, N.Y.

For more information circle **12** on inquiry card.

a new electronic flow meter!



Choice of 3 mercury-less transmitters

Hays Series flow or differential transmitter

Hays differential transmitter

Hays liquid level transmitter

continuous integration —no creep at zero

unaffected by normal voltage, frequency and temperature changes

electronic operation provides high speed and greater accuracy

3 to 1 range calibration at recorder

HAYS Electronic Flow Meter

Since the circuit is of the electronic null-balance type, it is unaffected by normal voltage and frequency variations. Also, neither temperature variations nor reasonable length of transmission lines affect the calibration of the instrument.

The *pen-drive motor* is built for reversing duty. Normal variations in voltage and frequency have no noticeable effect on its operation.

The *integrator* is continuous in operation and simple in mechanical construction. A micrometer zero adjustment for calibration is easily accessible.

Indicators can be calibrated to read directly in rate-of-flow or other factors as desired.

Write today for full information on the Hays Electronic Flow Meter Bulletin 52-1074-222.

For more information circle **13** on inquiry card.

Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
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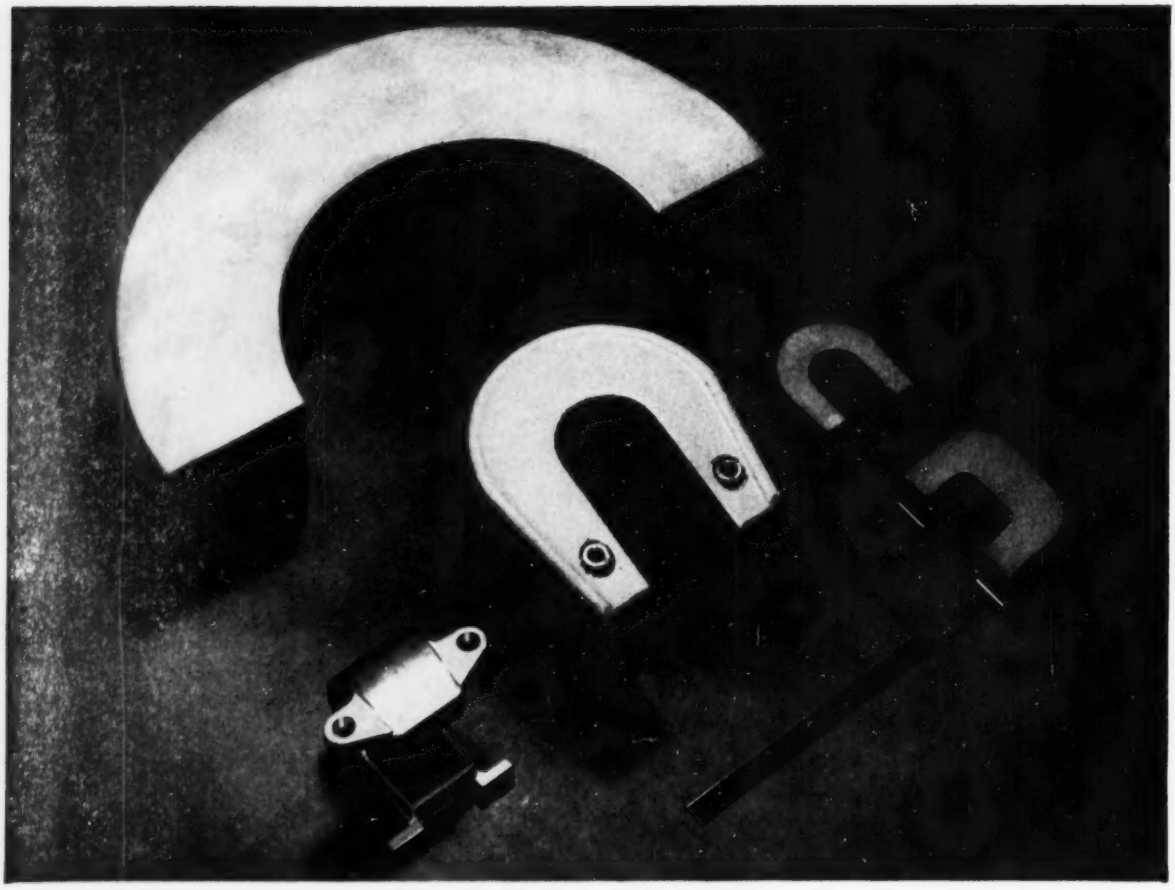
THE hays CORPORATION

MICHIGAN CITY 8, INDIANA



PERMANENT MAGNETS and ASSEMBLIES for Magnetrons and Traveling Wave Tubes

The group of magnets illustrated above, weighing from a fraction of a pound up to 75 pounds, are indicative of the wide range of Arnold production in this field. We can supply these permanent magnets in any size or shape you may need, with die-cast or sand-cast aluminum jackets, Celastic covers, etc. Complete assemblies may be supplied with Permendur, steel or aluminum bases, inserts and keepers as specified . . . magnetized and stabilized as desired. ● *Let Arnold handle your magnetron and traveling wave tube permanent magnet requirements.*

Made to your Specifications

. . . ANY SIZE, SHAPE OR COATING REQUIRED

★ *We'll welcome your inquiries*

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

DISTRICT SALES OFFICES . . . New York: 350 Fifth Ave.

Los Angeles: 3450 Wilshire Blvd. Boston: 200 Berkeley St.

For more information circle **14** on inquiry card.

NOT EVEN DRY CEMENT CAN PLUG THIS FLEX VALVE!

At Porete Manufacturing Co., North Arlington, N. J., where precast concrete roofing slabs are made, production depends on a constant supply of dry cement, unloaded through a pipe line under pressure. Using a rotary plug valve, it took 3 men an 8-hour day to handle 70 tons. Frequently the valve jammed after only half an hour of operation, making it necessary to force the action with a bar. Often, in cold weather, the valve had to be heated. Then Porete discovered Flex Valve. For more than two years the Flex Valve shown here has given trouble-free service. One man now controls the diaphragm-operated mechanism with a simple lever. If you have a problem in controlling the flow of any hard-to-handle fluid, send for Catalog No. FL 382C.

Exclusive FLEX VALVE Features

(Pat'd & Pat. Pending)

• Will outwear any metal valve on abrasive service. Proven minimum 11 to 1 life over metal • Full pipe capacity • Will not freeze up in outdoor service • Excellent control characteristics in first ⅓ of trave • Complete closure for bubble-air tightness • Tight on grits up to ⅛" • No obstructions, pockets, or internal parts • Valve body available in pure gum rubber, neoprene, butyl, buna-n, buna-s, food stock and special compounds.

YOUR MONEY BACK IF IT PLUGS

Representatives in Principal Cities

Farris

FLEXIBLE VALVE CORP.

Palisades Park, N. J., U. S. A.

Affiliates: FARRIS ENGINEERING CORP. • FARRIS STELLCOM CORP. • FARRIS HYDROSEAL CORP. • FARRIS HYDROTORQUE CORP. • FARRIS PICKERING GOVERNOR CO.

For more information circle **15** on inquiry card.

HANCOCK

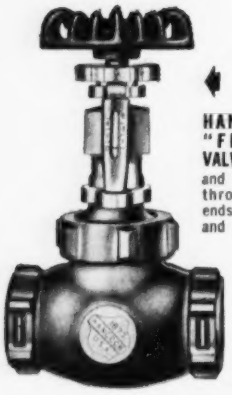
"FLOCONTROL" VALVES GIVE YOU PIN/POINT CONTROL

Here's manual control of flow, temperature and pressure that's really precise. Hancock "Flocontrol" Valves, with micrometer dial and pointer mounted on the bonnet, permit settings to within 1/100th turn of the handwheel! Equally important, any setting can be duplicated easily, perfectly — any time.

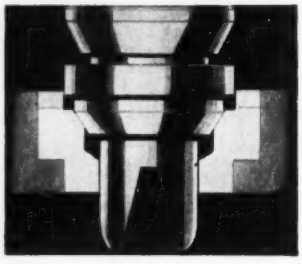
Hancock "Flocontrol" "3 in 1" design gives you the advantages of a variable orifice, plus a shut-off, plus an index... all in "one package." Bronze and steel types are available. Both have a scientifically designed V-Port valve disc that *compels proportional flow throughout the entire lift of the valve stem.* The shut-off seating surface is entirely removed and separate from the controlling V-Ports. Super-finished "500 Brinell" stainless steel seats and discs minimize the effects of wire-drawing and steam cutting.

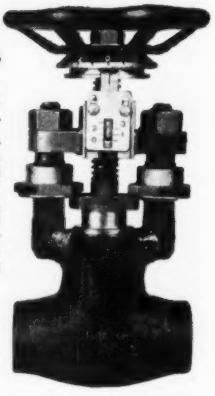
For fine throttling control and proportional flow... for greatest efficiency, lowest operating costs — install strong, dependable Hancock "Flocontrol" Valves in your lines. Your nearby Hancock Distributor will gladly give you full details.

When Hancocks go in, valve costs go down



HANCOCK BRONZE "FLOCONTROL" VALVES. Types: Globe and Angle. Sizes: ¼" through 2". Screwed ends. Available in 150# and 300# Series.





HANCOCK 600# STEEL "FLOCONTROL" WELDVALVES. Types: Globe and Angle. Outside Screw and Yoke. Sizes: ¼" through 4". Screwed, Socket Welding and Flanged Ends. Available with 150#, 300# and 600# Series Flanges.

VALVE SEAT AND V-PORT DISC fully closed. As the valve is opened proportional flow is gradually increased. The Hancock "Flocontrol" Valve has straight-line flow. Its regulation does not depend on the short-wearing, fine threads common to a needle valve.

YOUR LOCAL INDUSTRIAL SUPPLY DISTRIBUTOR is as close as your nearest telephone. His 24-hour emergency service and large stocks of the finest supply items simplify your purchasing and save money for you.

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** Watertown 72, Massachusetts

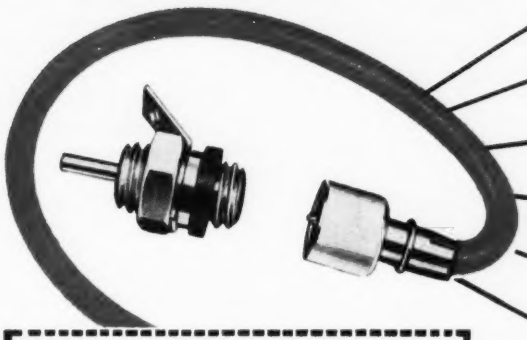
MAKERS OF 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

For more information circle **16** on inquiry card.

Are you *Design Competitive...*

Do your products feature Microdot® advantages?

Here's how MICRODOT COAX Connectors and Cables help you



Connector and Cable in this box is actual size

- TEFLON TEMP STABILITY
- UNIQUE CABLE FLEXIBILITY
- SMALLEST SIZE MADE
- LIGHTEST WEIGHT MADE
- SUPERIOR PERFORMANCE
- ENVIRONMENTAL PROTECTION

NEW!

Valuable MICRODOT ASSEMBLY KIT *for Design Engineers and Technicians:*

Microdot Engineers, realizing Design Group needs, developed this new Assembly Kit for practical reasons of design-in, pre-production and experiment. The new kit contains male and female plugs, receptacles, blind hole and panel mounts, BNC Adapters, feed throughs, couplings and 50 feet of coax cable, a self assembly tool and illustrated manual.

Order Kit #553 today by letter or wire . . . only $60.

Write for full information on Microdot standard coax connectors, pressurized coax connectors, coax cable types including Mininoise®. . . . assemblies and harnesses.

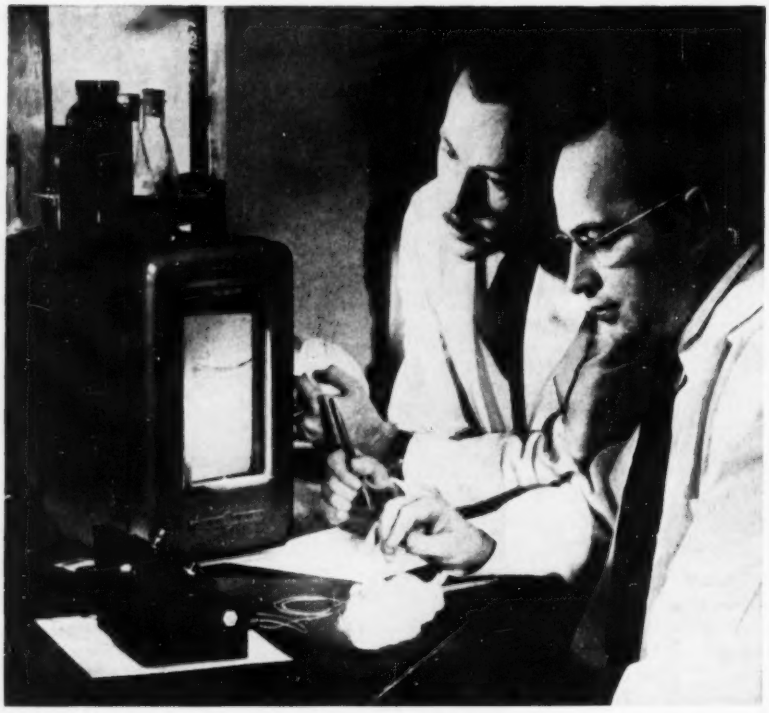
— the pioneer of micro-miniature components

MICRODOT DIVISION • FELTS CORPORATION

1826 Fremont Avenue, South Pasadena, California

For more information circle **17** on inquiry card.

LABORATORY INSTRUMENTS



Richard F. Gray and Dr. A. E. Axelrod of Western Reserve University, Cleveland, use the G-E photoelectric recorder to determine temperature gradient across skin of white rat specimen.

G-E Photoelectric Recorder Aids in Study of Radiation Effect on Skin

Under the sponsorship of the Atomic Energy Commission, the Institute of Pathology of Western Reserve University, Cleveland, Ohio, is engaged in experimentation on the resultant chemical changes in the skin when exposed to the effects of an intense source of heat.

In the study, a General Electric photoelectric recorder is connected to a thermo-sensitive resistor which is placed beneath the skin of a white rat. In this manner, a definite temperature gradient between the outside and the inside of the rat's skin is established for further study.

HIGH-SPEED RESPONSE

The General Electric photoelectric recorder is designed for recording rapidly changing phenomena with a minimum burden on the measured circuit. The instrument is available with a sensitivity as low as 1 microampere full scale. Response periods can be fast as $\frac{1}{5}$ second for full-scale deflection. Chart speeds range from $\frac{1}{2}$ inch per hour to 72 inches per minute. Prices start at $698.88*. For further information merely check coupon for Bulletin GEA-5536.

You can put your confidence in—

GENERAL ELECTRIC

Tilted Scale of New G-E Galvanometer Is Easy to Read from Any Position

With its scale surface tilted 15 degrees from the vertical, the new General Electric galvanometer is now easier to read from any position. Retaining such features as high sensitivity, flexibility, and easily interchangeable elements for different sensitivities, the new galvanometer now provides for a rough as well as a fine adjustment without opening the cover.

SELF-CONTAINED UNIT

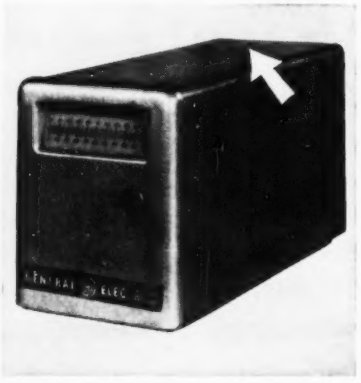
The new G-E galvanometer is a self-contained unit requiring only a 6v. d-c, or 120v.—60 cycle—a-c power supply. No separate lamp stand or scale is required.

PERMANENT HAIRLINE

To prevent damage to the hairline when replacing the light source, the new galvanometer features a permanent hairline scratched on the surface of the lens.

NEW METAL CASE

Conforming to the latest trends in laboratory-equipment design, an attractive, light metal case with gray hammer-tone finish now is used to enclose the instrument.



Small hole (arrow) for insertion of screwdriver permits rough zero adjustment without removing cover or jarring instrument.

FURTHER INFORMATION

The new General Electric galvanometer costs only $118.56*. For further information, contact your local G-E Apparatus Sales Office, or check coupon for Bulletin GEC-694.

For more information circle **18** on inquiry card.

FOR PRECISION MEASUREMENT

G-E Meter Is Used in High-temperature Research

Mr. A. G. Caswell, General Electric Laboratory Technician, is shown taking readings with a G-E insulation-resistance meter which is connected through spark plugs to test samples in oven.

Insulation samples are baked in high-temperature oven.

In studying high-temperature applications of motors, personnel of the Materials & Processes Laboratory of the General Electric Company are using the G-E insulation-resistance meter to determine the effect of high temperatures on various insulating materials. To provide an electrical path through the wall of a high-temperature oven, which is used to bake test samples, a method employing ordinary automobile spark plugs is used. The spark plug provides a junction for the instrument leads and the leads from the test sample in the oven.

Because this application requires many readings over a wide range of ohmic values, the G-E insulation-resistance meter has proved to be particularly valuable. Measurements can be made simply and quickly without hand cranking.

SAFER TO OPERATE

Designed for use wherever 115-volt, 50- or 60-cycle power is available, the meter is safer to operate because its maximum output current is limited to two milliamperes. Being compact and easily portable, and having a wide range of 0 to 20,000 megohms, the G-E insulation-resistance meter is extremely valuable in detecting insulation values or changes during design and development testing of electrical equipment.

Price is $304.20*. For further details, check coupon for Bulletin, GEC-753.

*Manufacturer's suggested retail price.

Laboratory Finds Portable Double Bridge Ideal for Transformer Heat-run Tests

The General Electric portable double bridge provides a simple method of measuring the precise resistance values of a transformer's windings during heat-run tests, a large industrial laboratory reported recently.

HIGH ACCURACY

Because of its high accuracy, the bridge has been found ideal for measuring resistance changes in the order of 0.00004 ohms encountered during transformer temperature-run tests. This degree of accuracy is important when making these measurements because the readings are multiplied many times in computing the temperature. Thus, even a minute error greatly affects the calculation.

WIDE MEASURING RANGE

For maximum utility, the G-E portable double bridge has eight ranges that permit measurements extending from 0.0001 to 22 ohms. It is accurate to 0.1 per cent of full-scale value, e.g., 0.000001 ohms at the lowest range.

OWN POWER SOURCE

The bridge saves time in measuring resistance because it contains its own power source and needs only one operator. Its price: only $334.62*. For more information check coupon for Bulletin GEC-251.

Designed for easy operation, the G-E portable double bridge has only one dial to adjust while making the measurement.

SECTION B 605-53, GENERAL ELECTRIC, SCHENECTADY 5, N. Y.

Please send me the following bulletins:

- ☐ Photoelectric Recorder (GEA-5536)
- ☐ Portable Galvanometer (GEC-694)
- ☐ Insulation-resistance Meter (GEC-753)
- ☐ Portable Double Bridge (GEC-251)

NAME .....

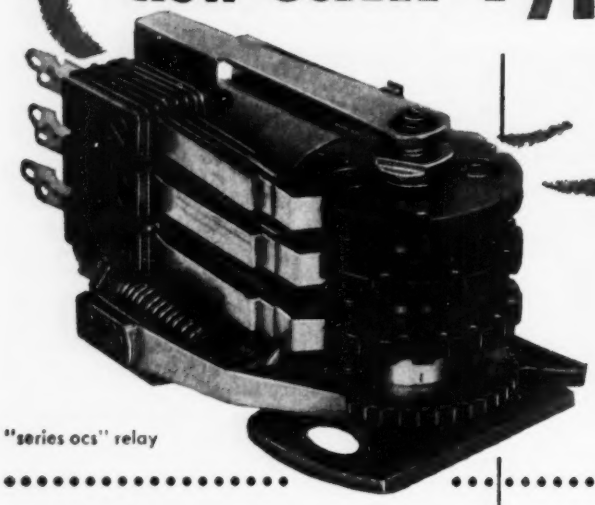
COMPANY .....

STREET .....

CITY ..... ZONE ..... STATE .....

For more information circle **18** on inquiry card.

new cam-type relay



"series ocs" relay

"series ocs" combines relay and stepping switch functions

"OCS" RELAY SPECIFICATIONS

cams—Each revolution is divided into 36 steps—any combination of "operated" or "unoperated" intervals can be provided.

contact arrangement—Maximum of 6 contact springs for each of the 3 cams.

spring contacts—Twin contacts. Will make and break load of 150 watts (maximum 3 amps.). "Heavy-duty" single contacts can be provided for higher current.

speed of operation—Self-interrupted, 65 steps per second; impulse-controlled, 30 steps per second.

voltages—Nominal dc voltages: 6, 12, 24, 48 and 110. A rectifier can be furnished for 115 volt, ac, 60 cycles.

vibration—Withstands up to 10.5 G.

shock and acceleration—Up to 25 G.

ambient temperatures— −55°C. to + 75°C.

weight—14-20 oz.

size—3 ¼" x 2-7/16" x 1-25/32".

. . . PROGRAMMING IS CUSTOM-DESIGNED

Here's a shock-resistant relay which can be used for cam-switching . . . for alternate on-off operations . . . or as a "stepper". *You* specify the programming when you order Automatic Electric's "OCS" Relay—select a contact sequence to fit *your* applications. This compact unit simplifies engineering—cuts space, weight, maintenance costs.

cam-switching — You can replace whole banks of relays and combinations of relays and stepping switches with this versatile unit. Dependability of the stepping mechanism is proved by performance records exceeding 250,000,000 high-speed operations! That's really performance!

alternate on-off operations — You can specify this rugged new relay as a replacement for the delicate latch-in type relay. "OCS" will give you excellent service under extreme conditions of shock, vibration, and temperature variation.

stepping operations — Stepping is high-speed, accurate and dependable. Can be driven self-interruptedly to produce a time cycle or for "homing".

Complete data on Automatic Electric's new "OCS" Relay can extend the scope of your planning. Write today to: Automatic Electric Sales Corporation, 1033 West Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

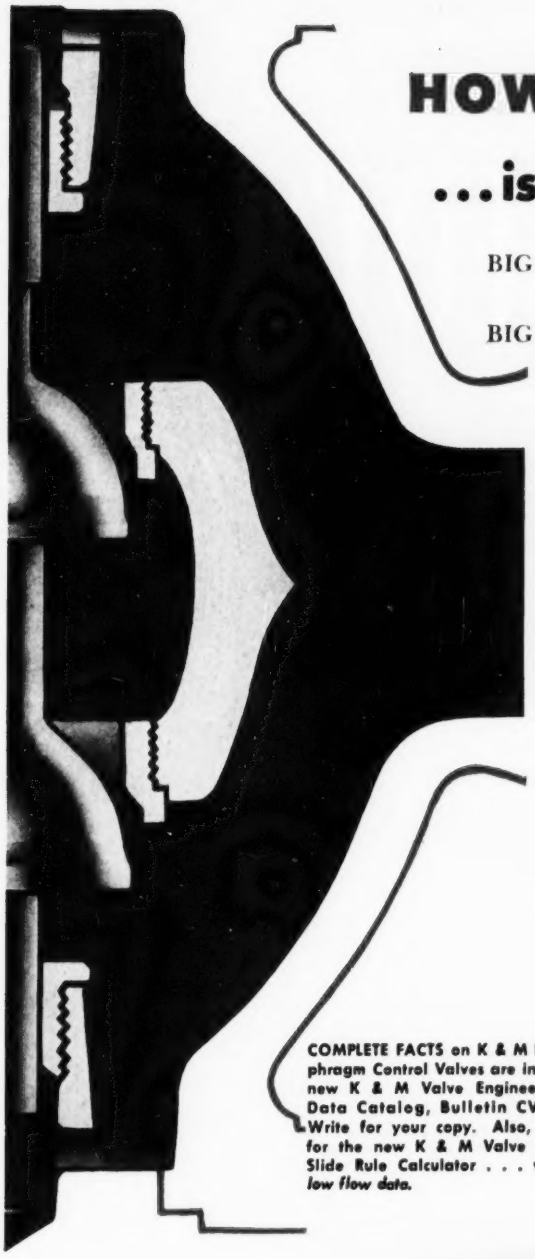
RELAYS **SWITCHES**

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

AUTOMATIC ELECTRIC

CHICAGO

For more information circle **19** on inquiry card.



HOW BIG

...is a K & M six-inch valve?

BIG enough to pass 500 gpm of cold water through the valve body at a constant drop of one pound pressure. BIG enough to provide the largest flow coefficient available in a standard six-inch diaphragm control valve. Body flow passages of all K & M valves, for example, actually average 140% of cross-sectional pipe area. There's more space for fluid to flow . . . smoothly, freely and without turbulence. Frequently a smaller nominal size K & M Valve provides sufficient capacity to satisfy requirements that formerly called for a larger, more expensive valve. Inner valve open areas, on the other hand, average only 80% of cross-sectional pipe area. Therefore, flow restrictions occur principally across the inner valve . . . where the restriction is controllable throughout the entire range of valve stem travel. This K & M design often permits lower initial costs . . . always contributes to more precise flow regulation through the K & M Inner Valve.

COMPLETE FACTS on K & M Diaphragm Control Valves are in the new K & M Valve Engineering Data Catalog, Bulletin CV53. Write for your copy. Also, ask for the new K & M Valve Size Slide Rule Calculator . . . with *low flow data.*

C_V COMPARISON TABLE

Valve Size	K & M	Valve B	Valve C
¾"	10.9	8.4	8
1"	17.3	14.9	12
1 ½"	39.1	33.2	28
2"	61	57	48
2 ½"	97.7	71.0	72
3"	150	116	100
4"	219	197	165
6"	500	364	360

Based on the maximum C_V at rated travel through the valve body. From manufacturers most recent slide rules or tables.

diaphragm control valves

KIELEY & MUELLER, INC.

K&M

Valve Makers Since 1879

64 Genung Street
Middletown, New York

For more information circle **20** on inquiry card.

Transistors*

in instrumentation . . .

*Transistors are capsule-size assemblies which utilize the physics of semi-conducting solids to produce the same effects as an electronic tube . . . but without cathode and/or filament and their circuitry components.

When ?

A timely statement from Walter P. Wills,
Director of Research, Brown Instruments Division
Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.

"PERHAPS you've wondered when transistors, with their widely publicized characteristics, will be put to work in industrial instrumentation. Naturally, I can speak only for my company, but I'd like to give you a research man's view on where transistors stand today.

"We agree that transistors have a tremendous future in all of electronics, including automatic control. Many problems, however, must yet be solved. Will they be made of germanium or silicon? Can they be made more reproducible and able to handle enough power at desired voltages? New circuits and new transistor types are needed. Today's costs are much too high. And let's not forget that the vacuum tube is still being developed after more than 40 years of existence.

"Even with extensive research and development programs, much more work remains before transistors can be broadly utilized in their natural markets—radio, television, and other communication equipment. Similarly, the few types now available do not nearly satisfy the requirements of industrial instrumentation.

"A 'tubeless' electronic instrument is theoretically possible today, and, on the basis of safety and reliability expected of modern instruments, it is anticipated that such a product is completely possible and practical in the future.

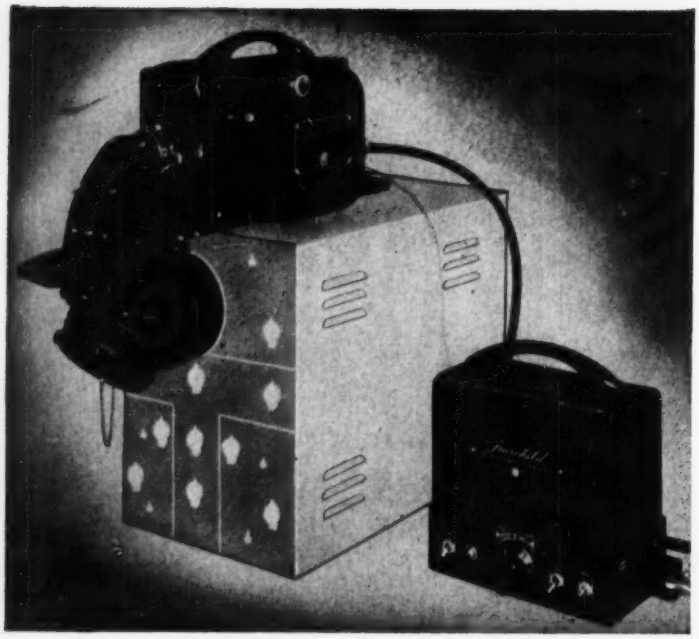
"So we're attacking the problem on a broad front. For upwards of five years, we've been devoting a large portion of our research facilities to studying ways to utilize transistors . . . looking on them not solely as replacements for tubes, but as the starting point for totally new instrument circuits.

"In addition, we have invested in the patent licenses and the know-how of Bell Telephone Laboratories, the pioneer of transistors. We have a large stake in providing instrumentation for the manufacture of transistors and hence are examining all facets of the transistor business . . . even to the extent of making some with our own hands.

"Honeywell instruments and other Honeywell controls using transistors will be on the market. When they are, you can be sure they will be great products—new, but the same kind of reliable, versatile, well-engineered products we sell today."

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

For more information circle **21** on inquiry card.



YOU GET THESE ADVANTAGES

with the FAIRCHILD OSCILLO-RECORD CAMERA

DESIGNED FOR both still and continuous-motion photography on 35-mm film, the Fairchild Oscillo-Record Camera records non-recurring phenomena that are too rapid for visual study, others that are so slow that continuity is lost, and the occasions where very high-speed transients are combined with very slow-speed phenomena. Oscillo-Record camera users especially like these advantages:

1. POSITIVE FILM DRIVE—Film is sprocket-driven synchronously with the take-up spool to prevent slippage and jamming at high speeds.

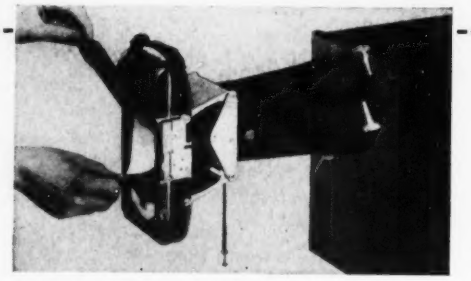
2. CONTINUOUSLY VARIABLE SPEED ADJUSTMENT—Film speed is electronically controlled over range of 1 to 3600 in. per min. No belts or pulleys are required.

3. TOP-OF-SCOPE MOUNTING—Controls are easily accessible. No tripod is needed.

4. VERSATILITY—Designed for both still and continuous-motion photography on 35-mm film. Provision for three lengths—100, 400, or 1,000 ft. For quick development and study of short lengths of film (up to 10 ft.) a special take-up cassette is available to help save time and reduce film wastage.

Fairchild-Polaroid® Oscilloscope Camera Provides Easy-to-Read Prints

For individual exposures the Fairchild-Polaroid Oscilloscope Camera provides speed, convenience, and economy. Trace reads normally—left to right. Reduction is exactly one-half size for easy measurement of values, especially with a grid. Each print is 3¼ x 4¼ and records two images.



One minute after you pull the tab, a finished print is ready for evaluation.

Complete information about applications and operation of the Fairchild Oscillo-Record and Fairchild-Polaroid Cameras awaits your request. Write today to *Fairchild Camera and Instrument Corporation, Robbins Lane, Syosset, Long Island, New York, Department 120-20F2.*

FAIRCHILD
OSCILLOSCOPE RECORDING CAMERAS

For more information circle **22** on inquiry card.

BARBER COLMAN

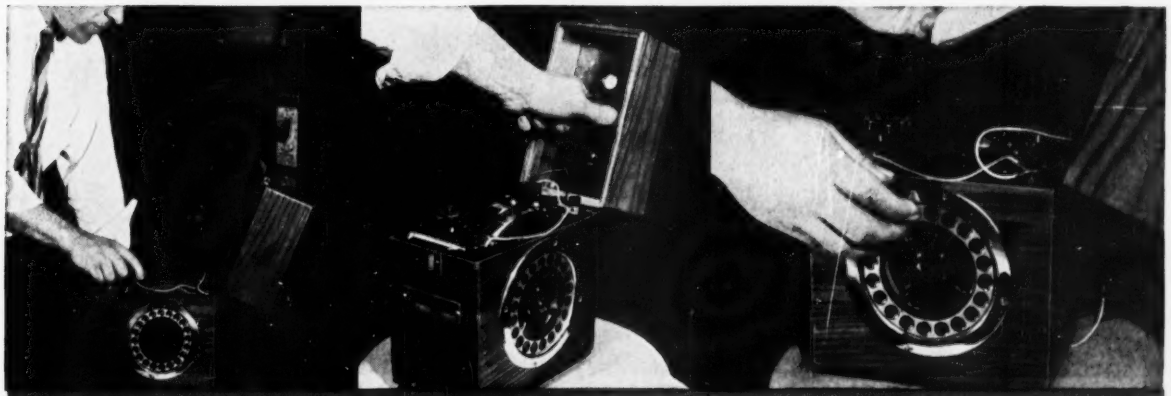
Wheelco Instruments

simple, easily portable . . .

checks accuracy, calibration

of all temperature instruments!

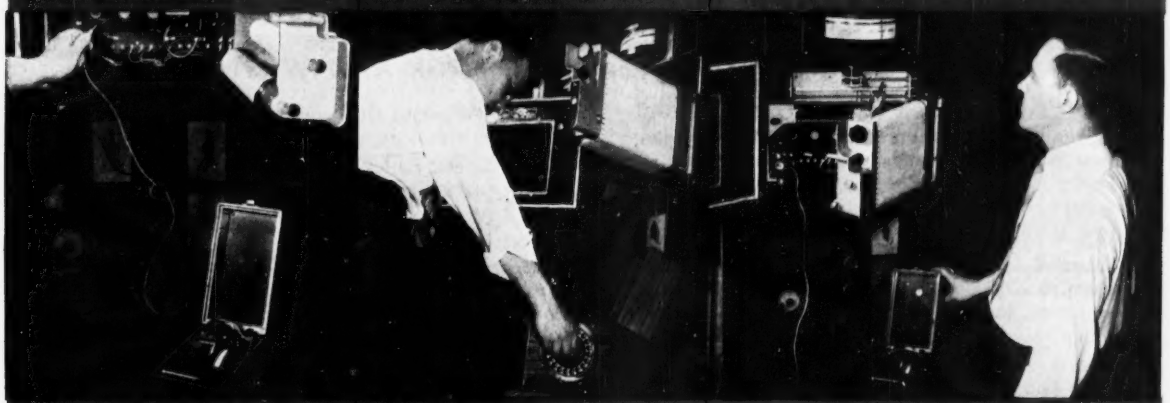
PORTABLE POTENTIOMETER—designed primarily for precision checking and calibrating of temperature measuring and control instruments . . . ideal for laboratory, plant or field service work. It's completely self-contained with a special compartment for dry cells supplying current to potentiometer circuit and voltage to energize instruments during calibration checks. This compact, packaged unit is accurate to .025 millivolts. Lightweight . . . designed for convenient handling . . . easy to operate. For free demonstration or descriptive catalog, send coupon below.



1 Operator adjusts for mechanical and electrical balance

2 . . . compensates for external resistance of meter being checked

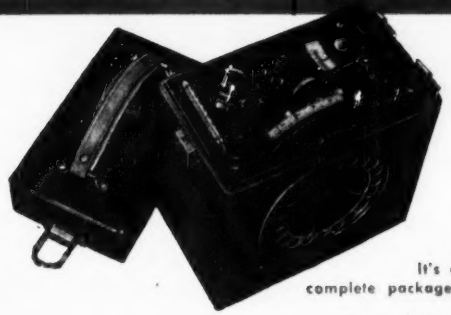
3 . . . sets slide wire for desired millivolt output



4 . . . joins leads to thermocouple terminals to check calibration

5 . . . balances galvanometer using rheostat in run-up circuit

6 . . . compares temperature of meter with output of Portable Potentiometer



It's a complete package!

WHEELCO INSTRUMENTS DIVISION, DEPT. J, 1515 ROCK STREET, BARBER-COLMAN COMPANY, ROCKFORD, ILLINOIS

☐ Would like to see demonstration ☐ Please send Bulletin A502-4

Name _____

Company _____

Address _____

City _____ State _____

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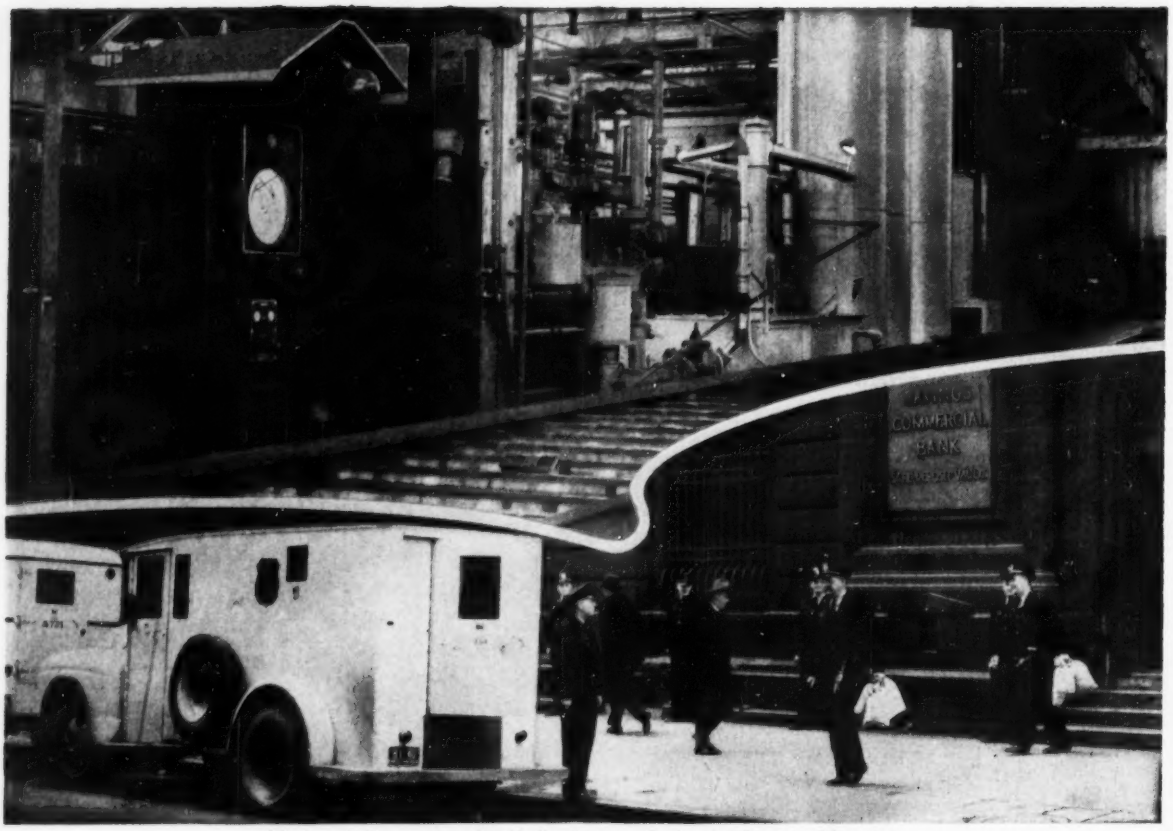


Modern Safeguards—Brink's for Money. Bailey for Process Materials

Are Your Process Materials Guarded As Well?

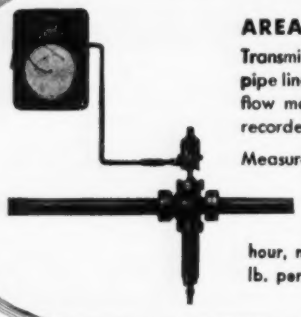
HERE'S HOW TO PREVENT SPOILAGE AND WASTE . . .

TO avoid waste of valuable process materials and finished products, process rates and conditions must be accurately measured and controlled. That's where Bailey Meters, Analyzers and Controllers can help you to improve the efficiency of your plant.

Take flow for instance. Bailey Meter Company offers a complete line of flow measuring and controlling equipment for applications ranging all the way from high pressure steam to low pressure gas. We measure flow in pipes, open channels, ducts, furnaces, smelters, kilns, ovens, dryers.

When you call Bailey Meter Company, you get the help of years of experience as well as recommendations from a wide selection of measuring and controlling devices.

Your local Bailey Engineer is as near as your telephone. He has the experience and the equipment necessary to set up an effective guard for your process materials.



AREA TYPE FLOW METER

Transmitter goes into 1, 2 or 4 inch pipe line like a valve and transmits flow measurements electrically to recorder in remote location.

Measures oil and other clear liquids under static pressures up to 600 psi. Minimum range 0 to 1200 lb. per hour, maximum range 0 to 96,000 lb. per hour.

BAILEY METER COMPANY

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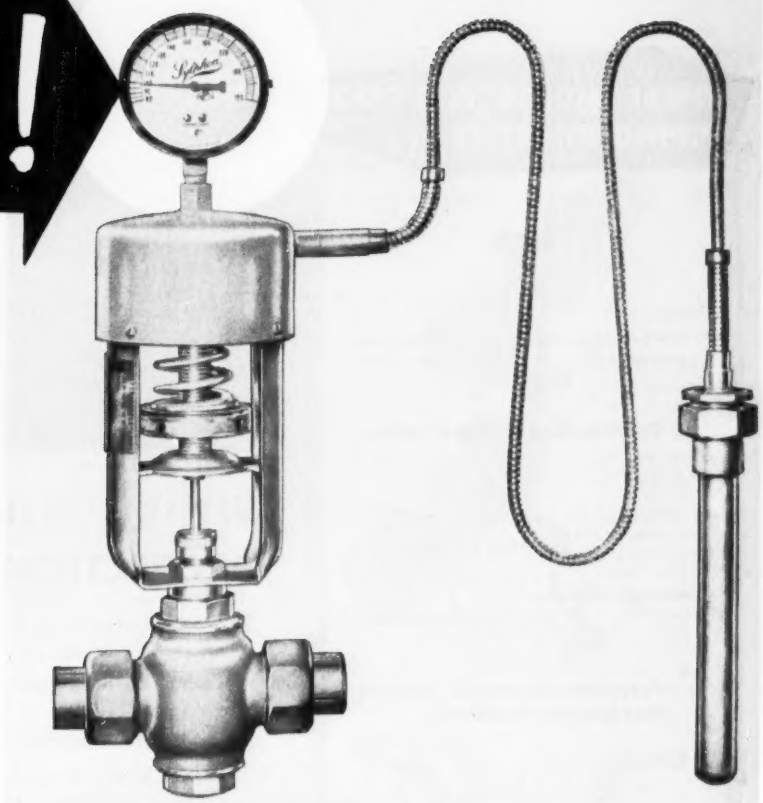
CLEVELAND 10, OHIO

Process Controls
TEMPERATURE · FLOW
PRESSURE · LEVEL
GAS ANALYSIS · RATIO

For more information circle **24** on inquiry card.

LOOK!

for simpler, more accurate temperature control



SYLPHON REGULATOR 999-T WITH DIAL-INDICATING THERMOMETER

WITH THIS Sylphon Regulator 999-T you can control processing operations better. For the dial-indicating thermometer tells you at a glance the temperature being maintained at the regulator bulb location. It eliminates the need for a separate thermometer adjacent to the bulb. And it helps make regulator adjustments easier, better, more accurate.

More advantages! 999-T has a stainless steel frame for minimum heat conduction from valve to regulator head. Its 2-ply Sylphon bellows provides added power. Less height and weight make it more compact. Self-operating—requires no auxiliary power source. Simply and sturdily constructed—ideal as standard equipment.

For added assurance of uniform processing conditions . . . for better performing equipment . . . for prevention of wasteful overheating . . . you can count on 999-T. Ideal for all industrial processing temperature control. Particularly suited for storage water heaters . . . metal plating tanks . . . bottle washers . . . treaters . . . slashers. For complete details, write for Catalog TE-A.

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FULTON SYLPHON
DIVISION

FIRST WITH BELLOWS

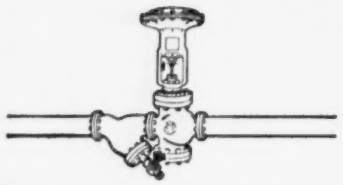
ROBERTSHAW-FULTON CONTROLS CO., KNOXVILLE 1, TENN.

Canadian Representatives, Darling Brothers, Montreal

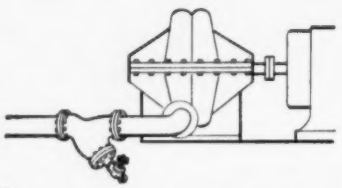
For more information circle **25** on inquiry card.

Which of over 150 Leslie strainers is the one for YOUR job?

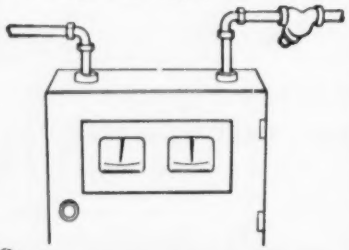
THREE "MUSTS" FOR GOOD PIPING PRACTICE . . .



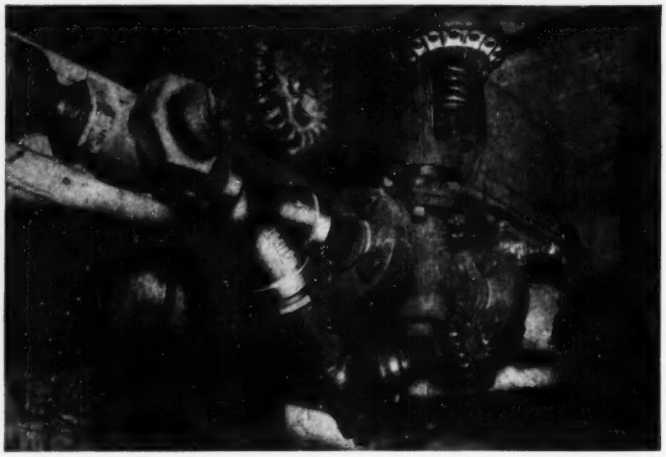
1. **For protection of control valves.**



2. **Protection of pumps, turbines and process equipment.**



3. **For superfine cleaning of air, steam and liquid flows, Leslie "Poromet" filters trap particles down to .001".**



WHICH WILL GIVE COMPLETE PROTECTION AT LOWEST COST?

Just considering strainer body material and screen specifications alone, there are over 150 *standard* combinations of "Y" type Leslie strainers. Each is engineered to do specific jobs under specific conditions . . . there's a "Leslie" for any industrial or marine pipeline strainer application.*

Then, with the myriad of pipe sizes and end connections, it's apparent that picking the right strainer to protect valuable equipment exposed to flow is *not* a "pin-the-tail-on-the-donkey" task.

***There are standard units for pressures to 2500 psi; temperatures to 1050° F; semi-steel, cast bronze, cast steel and cast alloy steel; screwed, flanged, welding or ring-type ends; sizes from ⅛" to 10".**

RESERVE YOUR FREE COPY OF 12 PAGE BULLETIN 5308

soon to be released, showing strainer dimensions, pressure drop charts and pressure-temperature limit tables. Reserve your copy today. Write LESLIE CO., 299 Grant Ave., Lyndhurst, N. J.

It costs no more...

to get the right equipment for the right job. In fact, it costs less. It will pay to call your Leslie Engineer before specifying strainers . . . or any pressure, temperature or level control equipment. He's listed in the classified telephone directory in principal cities—under "Valves" or "Regulators."

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TRADE LESLIE MARK

THE FIRST NAME IN PRESSURE, TEMPERATURE AND LEVEL CONTROLS
Since 1900

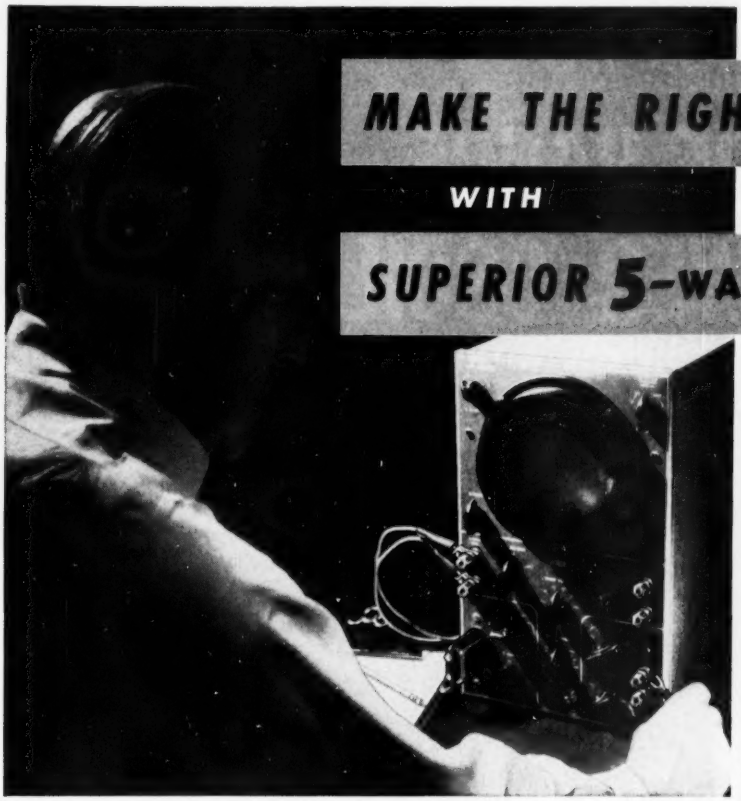
LESLIE CO., 299 Grant Avenue, Lyndhurst, New Jersey

For more information circle **26** on inquiry card.

MAKE THE RIGHT CONNECTIONS

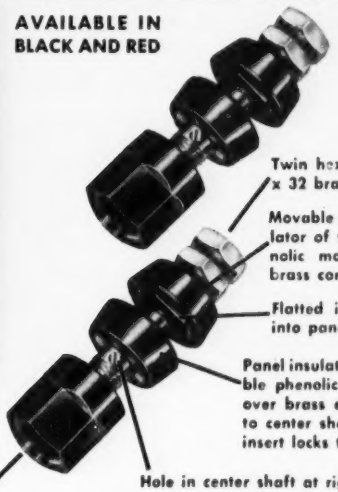
WITH

SUPERIOR 5-WAY BINDING POSTS



AVAILABLE IN BLACK AND RED

ACTUAL SIZE



Twin hexagonal 10 x 32 brass nuts.

Movable panel insulator of tough phenolic molded over brass core.

Flatted insert locks into panel.

Panel insulator of durable phenolic is molded over brass core frozen to center shaft. Flatted insert locks to panel.

Hole in center shaft at right angles to insulator flatted surface for permanent clamping accommodates wire up to size No. 12.

Phenolic hex-shaped thumb nut with insert is captive with stud.

5 CONNECTIONS

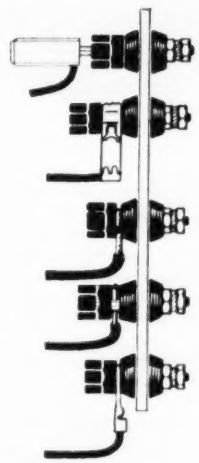
1 Plug-in for standard ¾" banana plug

2 Clip-lead to shaft

3 Wire looped around shaft and clamped

4 Wire (up to No. 12) permanently clamped through center hole

5 Clamped spade lug



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- VARICELL D-C POWER SUPPLIES

THE SUPERIOR ELECTRIC COMPANY
710 Mae Avenue, Bristol, Connecticut

Please send a copy of the Superior Electric 5-WAY Binding Post Bulletin BP652.

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For more information circle **27** on inquiry card.

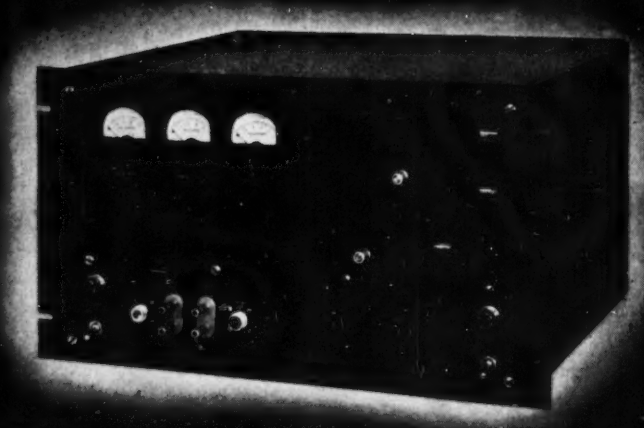
PRECISION ENGINEERING
CUSTOM MANUFACTURING

WIDE-RANGE POWER OSCILLATOR

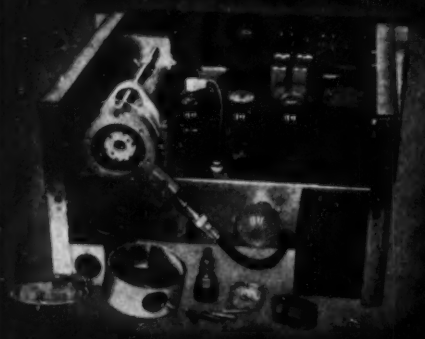
CONTINUOUS COVERAGE

CONTINUOUS CONTROL WITHIN RANGES
FROM 300 to 900 mc and 900 to 2,500 mc
SEPARATE OUTPUT COUPLING CONTROL

300 to 2500 mc
More than 10w to 1200 mc
More than 2.5w to 2500 mc



$2,285.00
F.O.B. MINEOLA, N.Y.



The 124A Power Oscillator consists of a grid-separation coaxial oscillator employing a 2C39A disc seal triode, an audio oscillator and modulation section, and a self-contained rectifier power supply. A selector switch is provided for the following: internal modulation of 400 or 1,000 cps, cw, or external modulation by pulse or square wave sources. Grid-cathode and grid-plate lines are coupled to a single tuning control, with provision for individual adjustment of the grid-cathode line when desired. Counter-type indicators show the position of the tuning elements. An output coupling control with counter indicator is provided.

This is one of a series of especially fine instruments and components that have been developed by AIL to meet our own exacting requirements. Our research and development work has demanded equipment not ordinarily available in the electronics market. Thus, we have developed devices that are considerably advanced over those usually available for purchase. Originally we were requested to produce limited quantities for our established clientele. The demand has grown to a point where limited production runs have become necessary. Under these circumstances immediate delivery is often possible.

We suggest that you write at once for specifications and delivery schedules.

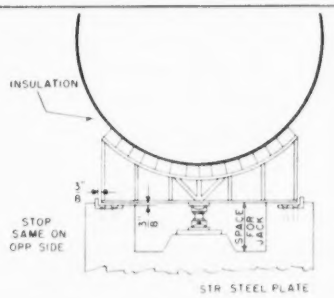
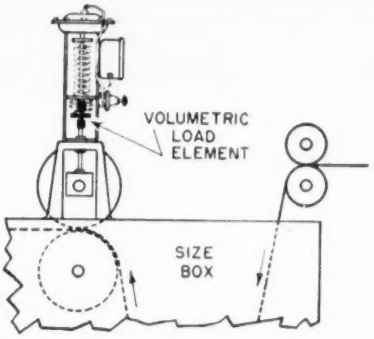
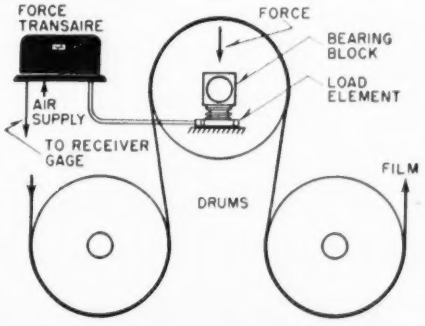
Airborne Instruments Laboratory

INCORPORATED

160 OLD COUNTRY ROAD MINEOLA, N.Y.

Let us take a load off your mind!

DO YOU have a tricky load measurement problem on your mind? Something like measuring the tension on a conveyor belt for example, or the thrust on a bearing, or the weight of solids or corrosive liquids in a tank . . . ? Taylor volumetric load measuring elements have been used for years in paper mills, but there are many applications throughout the industry where these highly accurate and sensitive instruments are proving invaluable. Most recent developments afford a wide variety of ranges, greater range suppression, greater over-range protection and greater energy for positioning the pen or actuating a control mechanism. Applicable to tension and compression loads. Call your Taylor Field Engineer or write for **BULLETIN 98232.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

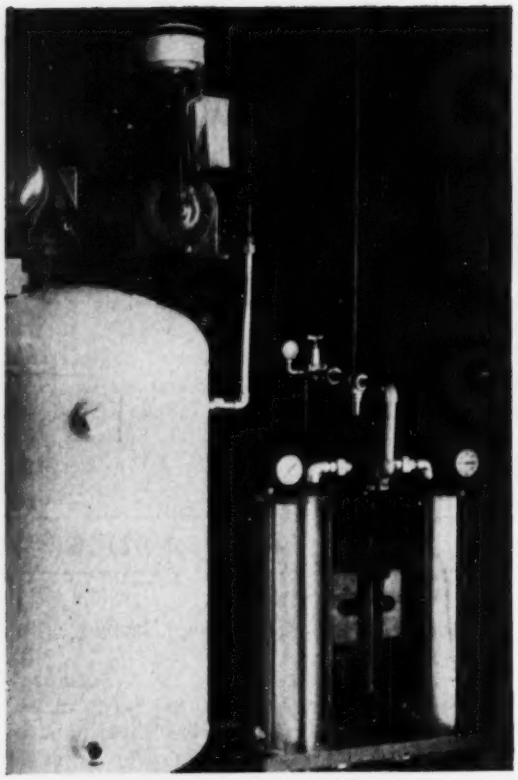
PROBLEM	SOLUTION	CHARACTERISTICS
To accurately measure the weight of chlorine in tanks		**Spool type Load Measurement Element** **Range limits:** 0-240,000 lbs. for compression loads, maximum load not to exceed 400,000 lbs. Applicable to horizontal or vertical tanks, containing corrosives or solids, making conventional level measuring devices impractical. Tension loads 0-30,000 lbs.
To accurately measure squeeze roll pressures on textile slashers		**Diaphragm type Load Measuring Element** **Range limits:** 0-5,000 lbs., maximum load not to exceed 6250 lbs. Compound ranges, tension—0—compression also available. Applicable to measure roll or nip pressures in calender stacks, press section and many other finishing operations involving processing of material between rolls.
To measure film tension within very close limits as a measure of "gain" or percentage of stretch		**Transaire Volumetric Load Measuring Element** **Range limits:** 0-300 lbs. in range spans as short as 30 lbs. Used in conjunction with a TANSAIRE* Pressure Transmitter which sends an output air pressure to an indicating, recording or controlling receiver proportional to the force applied. Applicable to film, paper, yarn or similar tension measuring requirements.

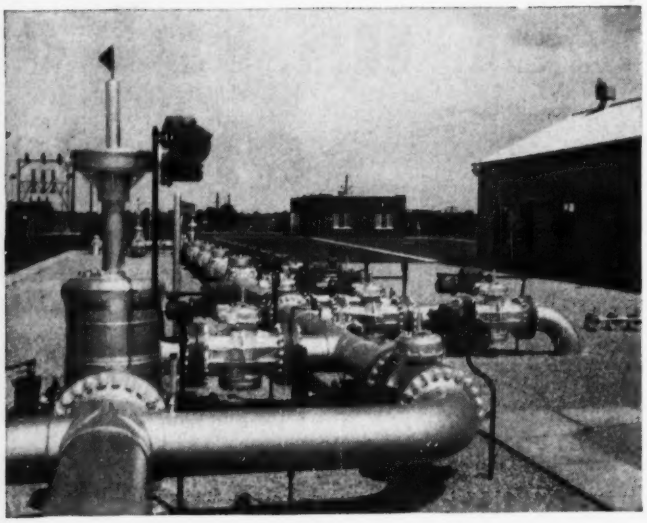
*Reg. U.S. Pat. Off.

TAYLOR INSTRUMENTS MEAN ACCURACY FIRST

For more information circle **29** on inquiry card.

←——Circle **28** on inquiry card.





This Lectrodryer, tiny but dependable, dries the air as it goes into the receiver. Automatic instruments feed it to lines controlling pumps in the building to the right and to valves on this pipeline distribution manifold.

LECTRODRYERS* keep moisture from choking automatic controls

Air-actuated instruments trigger valves, start pumps and keep traffic-control-indicators alive at this Platte Pipeline pumping station, Salisbury, Missouri. Moisture in the instrument air can kill this entire automatic operation.

That's why these pumping stations are equipped with Lectrodryers . . . to do away with the moisture that might choke air lines and controls with ice, rust, scale and sludge. Air from the compressors first passes through a Lectrodryer. And, no matter how high the humidity is out-of-doors, no moisture gets past this dryer into the lines.

Elsewhere in Industry, Lectrodryers are DRYing air, gases and organic liquids; preventing contamination of products, helping to hold delicate reactions on the beam and speeding up production. Standard models, proved in many years of service, are available . . . to handle small or tremendous volumes, pressures up to 6,000 psi, dewpoints below −110° F.

The booklet, "Because Moisture Isn't Pink", describes many of these installations. Write for a copy, or tell your troubles with moisture to Pittsburgh Lectrodryer Corporation, 330 32nd Street, Pittsburgh 30, Pa.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Beige Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

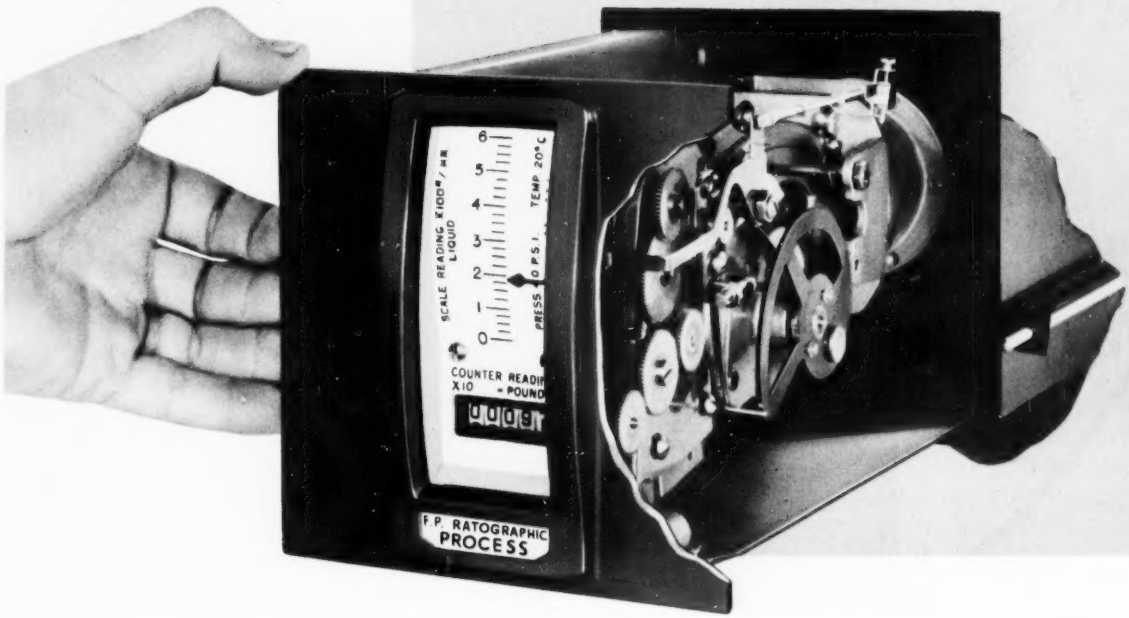
*REGISTERED TRADEMARK U.S. PAT. OFF.

For more information circle **30** on inquiry card.

Circle **31** on inquiry card. ⟶

NEW

Ratographic* totalizer



complete with continuous rate indication

- continual integration at rate of 24 times per minute
- dust-proof drive mechanism immersed in oil
- heavy duty 100 rpm — 72 pole synchronous motor
- standard size pneumatic receiver and integrator
- front-of-panel accessibility and removal
- accuracy within 1% of full scale

Here, for the first time, is a *full-size*, rugged totalizer — so designed that it can be used in full size, miniature or graphic panels. A companion to the F & P Ratographic miniature indicator, it is another step in complete process instrumentation developed and perfected by the skilled engineers at Fischer & Porter Company.

The entire unit occupies only six inches square of panel space. In extended position, as shown, instrument continues to function, thus easily enables observation of mechanism. The highly accurate integrating unit gives the equivalent of continuous integration. The many other new features combined in this instrument suggest a careful comparison. Full information on request.

*T.M., F&P Co.

complete process instrumentation

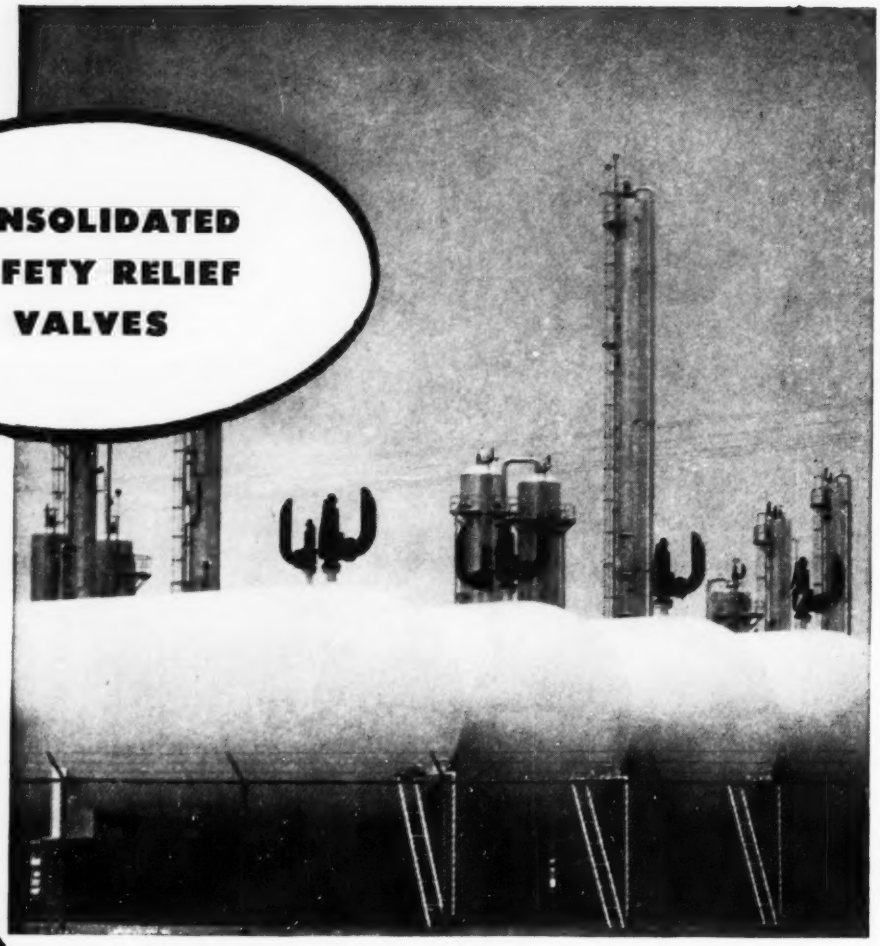
FISCHER & PORTER CO.

1400 County Line Road, Hatboro, Penna.

2241

Company owned sales and service branches strategically located throughout the world.

CONSOLIDATED SAFETY RELIEF VALVES



OUTSTANDING FOR SAFE SERVICE

ABSOLUTE PROTECTION against overpressures is the one and only function of Consolidated Safety Relief Valves—and they give it. Proof of their unbeatable performance is evident in the many unfired pressure vessels—gas, vapor and liquid storage tanks, pipelines, pumps—safeguarded by these valves throughout the processing industries.

You want complete protection for your personnel, property and equipment. Consolidated Safety Relief Valves provide it. They don't leak under discharge piping stresses—outside bevel seat and floating guide construction permit the disc to seat on a radial seating surface. **Dependable tightness** is assured in all positions within the deflection range. You can be sure of continuously reliable performance at the rated capacity, even in the most severe service.

Invest in Consolidated Safety Relief Valves and you also get the fundamental advantage of **simple design**—high quality valves that serve better and longer because they have 25% fewer parts than ordinary safety valves.

Your local Consolidated Safety Relief Valve Industrial Distributor will explain how much this can mean to you in economical maintenance and simplified standardization. Phone or write him today. He is your best source for quick information and service.

1879 CONSOLIDATED U.S.A.

CONSOLIDATED SAFETY RELIEF VALVES

MAXWELL MANNING MM & MOORE TRADE MARK

A product of **MANNING, MAXWELL & MOORE, INC.** TULSA, OKLAHOMA

MAKERS OF 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

For more information circle **32** on inquiry card.

ELECTRONIC TEST INSTRUMENTS

Read the

HEWLETT-PACKARD
JOURNAL
TECHNICAL INFORMATION FROM THE -hp- LABORATORIES
...for up-to-the-minute news of electronic developments, techniques and instrumentation, sent regularly without charge

The *-hp-* Journal is an engineering periodical sent to you as another service of the Hewlett-Packard Company. It is written for engineers, by engineers. Typical papers discuss such subjects as:

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Articles also contain technical data, performance information and operating suggestions for *-hp-* test instruments. All issues are fully illustrated.

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WORLD'S LARGEST EXCLUSIVE MANUFACTURER OF ELECTRONIC TEST INSTRUMENTS
Vacuum Tube Voltmeters - Audio Oscillators - Frequency Counters, Monitors and Standards - Audio, VHF, UHF and SHF Signal Generators - Square Wave Generators - FM and TV Broadcast Monitors - Wave and Distortion Analyzers - Slotted Lines - Tunable Bolometer Mounts - VHF Bridges - VHF Detectors - Microwave Test Equipment and Power Meters - Standing Wave Indicators - Low Pass Filters - Electronic Frequency Meters - Attenuators - Wide Band Amplifiers - Regulated Power Supplies - Electronic Tachometers Voltage Dividers, Multipliers, Shunts - Accessories

Instruments for *Complete* Coverage

← Circle **32** on inquiry card. For more information circle **33** on inquiry card.

REALLY *New!*

ACTUAL SIZE

COMPLETE *miniature* FREQUENCY STANDARD

A compact, complete, hermetically sealed frequency standard, presenting these features:—

1. JAN-ized construction throughout.
2. SPACE-SAVING, 1½" dia. x 4½" high.
3. WEIGHT, approximately 10 ounces.
4. AVAILABLE in 400 and 500 cycles.
5. ACCURACY—.002% (15° to 35°C).
6. SHOCK-MOUNTED on Silicone rubber.
7. POWER REQUIRED, 6 V. at 300 ma. 70 to 200 V. at 1 to 5 ma.

WRITE FOR DESCRIPTIVE LITERATURE, SPECIFYING "TYPE 2007"

Also, manufacturers of frequency standards, multi-frequency standards, chart-recording chronographs, firing-cycle timers, the Watch-Master Watch Rate Recorder and other high-precision frequency and timing instruments, controlled by our tuning-fork oscillators.

Engineers!

Gear this frequency standard to your designs and help solve climatic, space and weight problems in JAN-ized-MIL equipment

American Time Products, Inc.

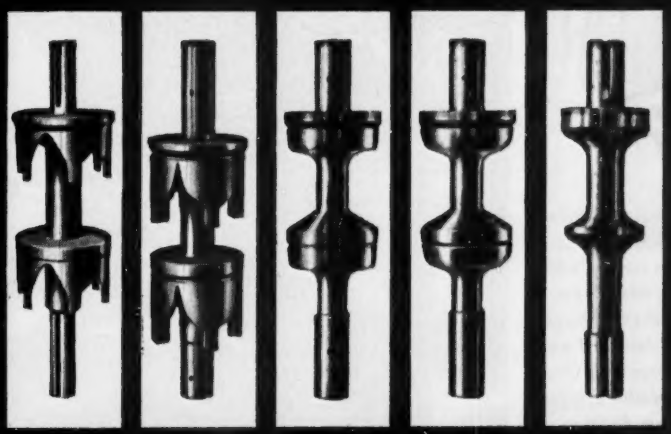
580 Fifth Avenue ***New York 36, N. Y.***

MANUFACTURING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY

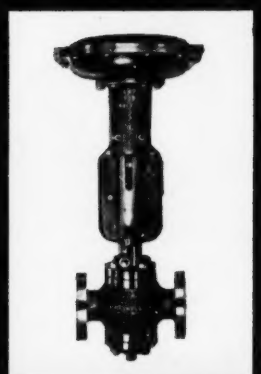
For more information circle **34** on inquiry card.

For more information circle **35** ⟶

WIDE SELECTION . . .



for any valve application



Discs for the Honeywell Series 700 Valve include single and double-seated V-ported and contoured types, each with either linear or equal-percentage characteristics, plus a flat disc for on-off control . . . all ground and polished. . . . all designed to retain characteristics under severe service. The Honeywell Series 700 Valve comes in a full range of styles and sizes . . . has *all* the features you look for in a fine valve. Write today for your copy of Bulletin 700-2. MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 1908 Windrim Avenue, Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
VALVE PRODUCTS

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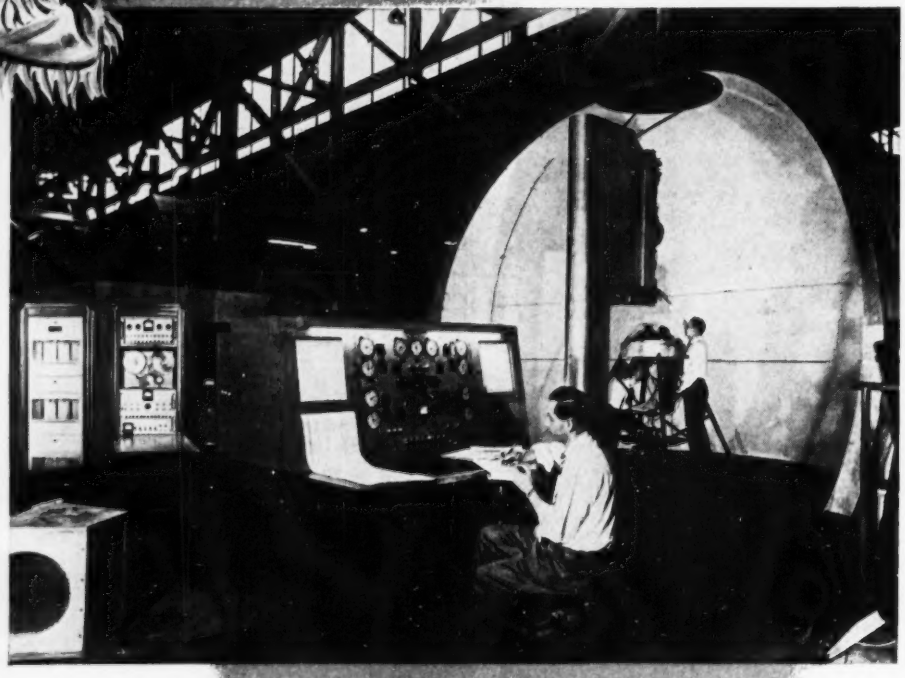
HONEYWELL

First in Controls

Takes more than a quick eye

TODAY!



12-Information Channel-Playback System for use with The Glenn L. Martin Co.'s new T-13 Gunnery Trainer, designed and developed by Cook Research Laboratories, a division of Cook Electric Company.

AIMING HIGH today calls for more than just "drawing a bead." Split-second timing is absolutely essential to the operation of the intricate instrumentations and equipment necessary to give adequate training in gunnery to both our anti-aircraft troops and to our jet pilots.

Eleven STANDARD ELECTRIC Model S-1 Timers are shown on the large control panel in the center of the photograph above.

STANDARD

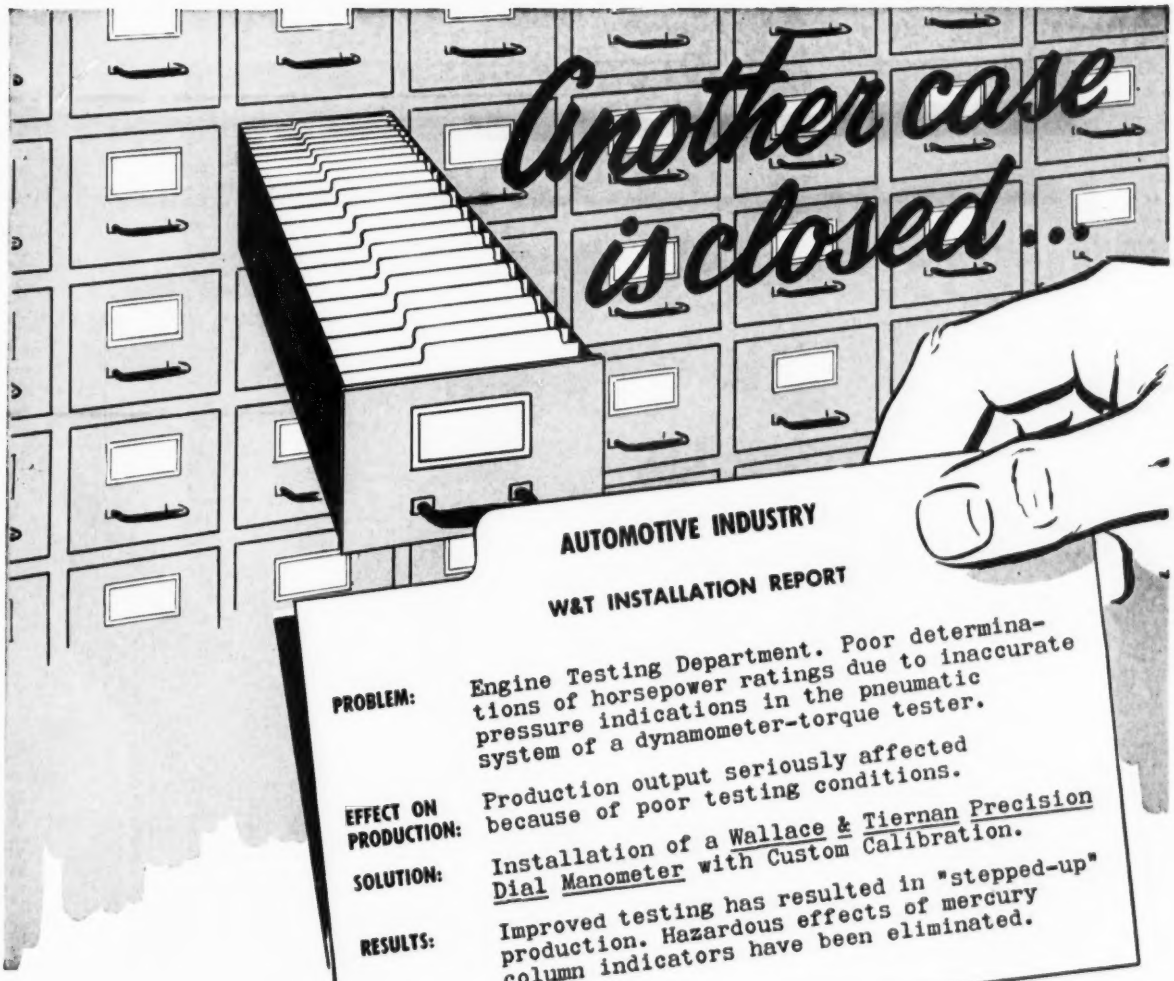
Serving industrial, governmental and educational institutions since 1884.

The STANDARD ELECTRIC TIME COMPANY

93 LOGAN STREET • SPRINGFIELD 2, MASSACHUSETTS

PRECISION TIMERS • CHRONO-TACHOMETERS • LABORATORY PANELS • PIPELINE NETWORK ANALYZERS

For more information circle **36** on inquiry card.


another case is closed...
AUTOMOTIVE INDUSTRY
W&T INSTALLATION REPORT
PROBLEM: Engine Testing Department. Poor determinations of horsepower ratings due to inaccurate pressure indications in the pneumatic system of a dynamometer-torque tester.
EFFECT ON PRODUCTION: Production output seriously affected because of poor testing conditions.
SOLUTION: Installation of a Wallace & Tiernan Precision Dial Manometer with Custom Calibration.
RESULTS: Improved testing has resulted in "stepped-up" production. Hazardous effects of mercury column indicators have been eliminated.

...Thanks to a W&T Precision Instrument

W&T Precision Dial Manometer

FEATURES:

Full protection against overpressure
Custom calibrated scales in units of force or torque
Two revolution indicator provides scale 45 in. long with only an 8½ in. diameter dial.
Sensitivity one part in 10,000; accuracy one part in 1000.
If you have a problem in the measurement or control of pressure, write today for additional information.

WALLACE & TIERNAN
PRODUCTS, INC.
ELECTRICAL MECHANISMS AND PRECISION INSTRUMENTS
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In Canada, Wallace & Tiernan Products, Ltd. — Toronto

A-93

For more information circle **37** on inquiry card.

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters

Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.

do you really need marginal precision in instrumentation?

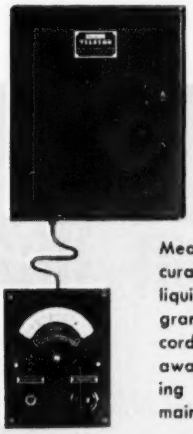
marginal accuracy can be costly

especially if extreme accuracy isn't really essential. That's why thousands of instrument users now specify Fielden *simplified instrumentation*; they get all the accuracy they can possibly use—at a substantial saving.

example #2

Fielden TEKTOR Electronic Level Control

Accurately controls or indicates level of any material, wet or dry, liquid or divided solid, conducting or non-conducting. A change of even 1/16" in liquid level causes TEKTOR to function. Simple, highly stable control circuit. Low-cost installation and maintenance.



example #1

Fielden TELSTOR Electronic Level Indicator

Measures continuously—with accuracy to ±2%—the level of liquids, viscous fluids, powders or granular solids. Indicates or records at stations one mile or more away. Simplified design. No moving parts. Low initial cost and maintenance.

example #3

Fielden TEKTOLOG–Accurate Electronic Recorder

Accurate to ±1% full scale or better. Highly adaptable; can be mounted or portable. Simplified recorder mechanism consists of 4 principal units—easily removed and replaced. Much less expensive than servo-operated potentiometer type recorders. Use in most circuits without modification.

MAIL COUPON FOR FULL DETAILS

Send full details of Fielden simplified

☐ TELSTOR Electronic Level Indicator

☐ TEKTOR Electronic Level Control

☐ TEKTOLOG Electronic Recorder

*Name*_____

*Title*_____

*Company*_____

*Address*_____ *City*_____ *State*_____

DOLLAR FOR DOLLAR . . . YOUR BEST INSTRUMENT VALUE

Fielden

INSTRUMENT DIVISION

ROBERTSHAW-FULTON CONTROLS COMPANY

2920 N. 4th St., Dept. A. Philadelphia 33, Pa.

For more information circle **38** on inquiry card.

ELECTRIC RANGES at General Electric's Appliance Park in Louisville, Kentucky, move through furnace for firing of porcelain-enamel finish. G-E pyrometers (Type HP-3) provide the close temperature control required to properly harden the finish.

QUALITY CONTROL THROUGH CLOSE TEMPERATURE CONTROL . . .

G-E Pyrometers Help Sustain Quality

Known the world over for its fine electric kitchen ranges, General Electric's Appliance Park in Louisville, Kentucky is now using one hundred HP-3 pyrometers in its manufacture of ranges. These instruments control the critical furnace temperatures required for proper firing of the porcelain-enameling on range shells.

Precise and complete temperature control is essential to the quality control of any product undergoing heat processing. The proven close control afforded by G-E HP-3 pyrometers can help you to keep rejects at a low level, while maintaining product quality at the peak demanded in return for customer satisfaction.

Precision control—at low cost—is inherent in the HP-3 pyrometer features which follow:

PRECISION CONTROL

G-E pyrometers will read the same everytime temperature conditions are the same. That's repeatability—the essence of precision control. A repeatable process means you get identical results, assuring uniform high quality.

Low-cost precision control begins with G.E.'s low pyrometer prices, starting at $215.78.*

HIGH SENSITIVITY

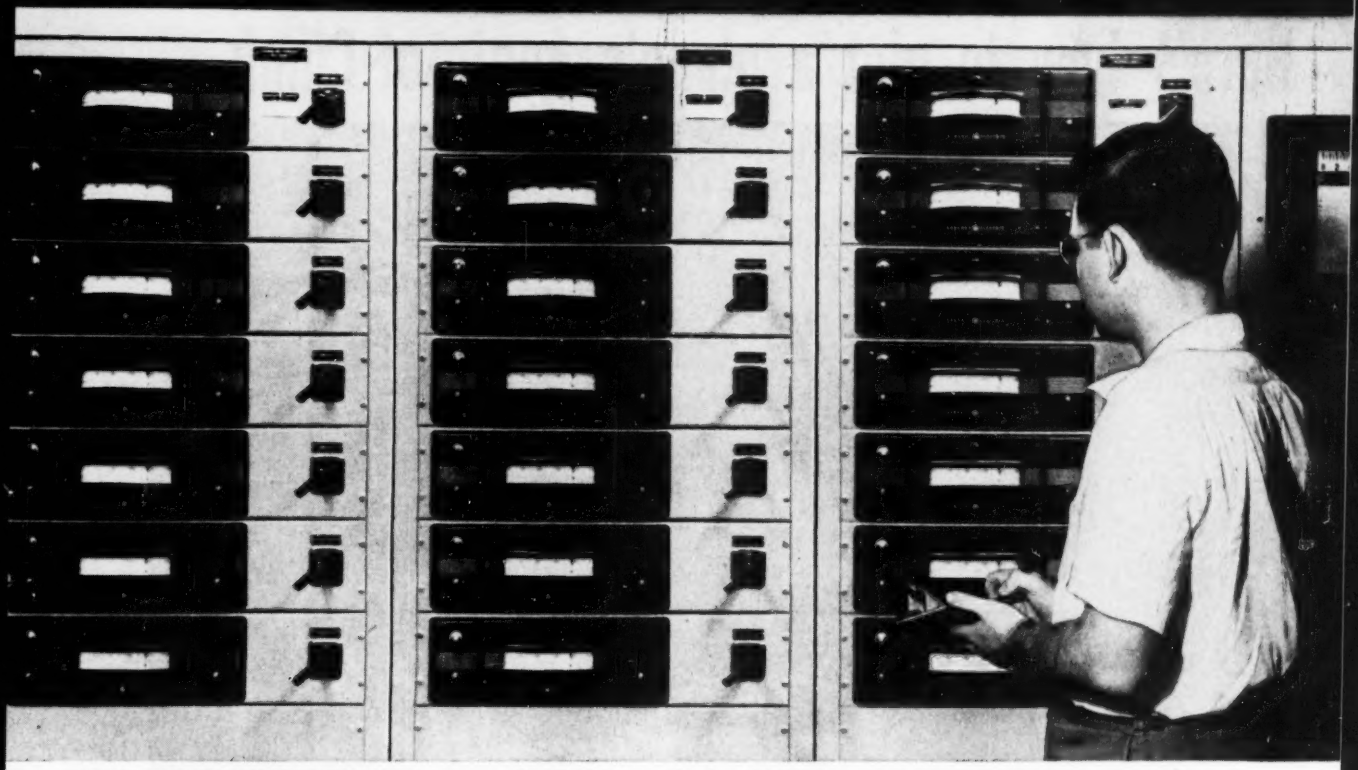
Any change in furnace temperature equivalent to 2/10 of 1% of full scale is enough to initiate control action. Effective sealing of all removable parts helps keep dirt and moisture from offsetting this sensitive control.

SUSTAINED HIGH ACCURACY

Accurate indication and control is provided by: (1) cali-

GENERAL ELECTRIC

For more information circle **39** on inquiry card.



TWENTY-ONE G-E PYROMETERS insure proper distribution of temperature throughout the eighty-eight-foot zone of each furnace. This precise and extensive temperature control is a major factor in assuring a high-quality porcelain-enamel finish.

# of Porcelain Finish on Electric Ranges

brated accuracy of ¾ of 1% of full scale; (2) automatic cold-junction compensation, which adjusts for changes in ambient; and (3) high stability during changes in voltage, frequency, or humidity.

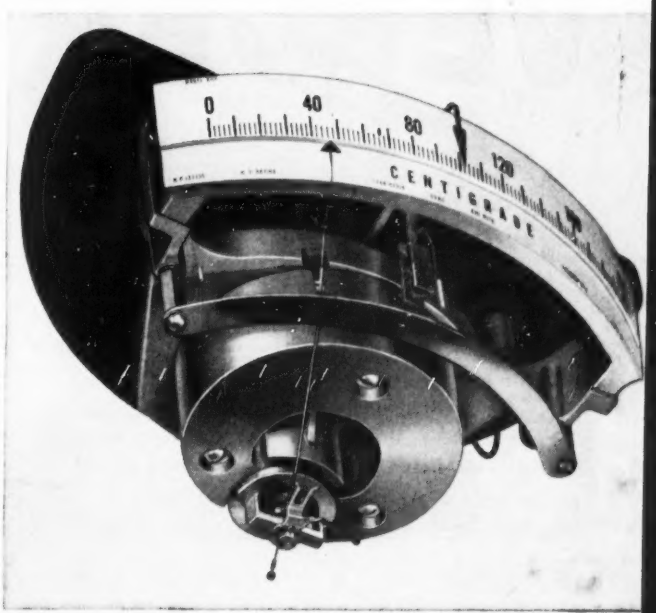
SEVERAL TYPES AVAILABLE

HP-3 pyrometers are available as indicators, indicator controllers, and protectors in either 2-position or 3-position models. Scale requirements can be fulfilled from a variety of ranges in the 0-3000 F span.

MORE INFORMATION

For complete information on how G-E pyrometer equipment can help you to improve or maintain product quality, contact your G-E Apparatus Sales representative, or write for Bulletin GEC-713 to General Electric Company, Section 602-263, Schenectady 5, N. Y.

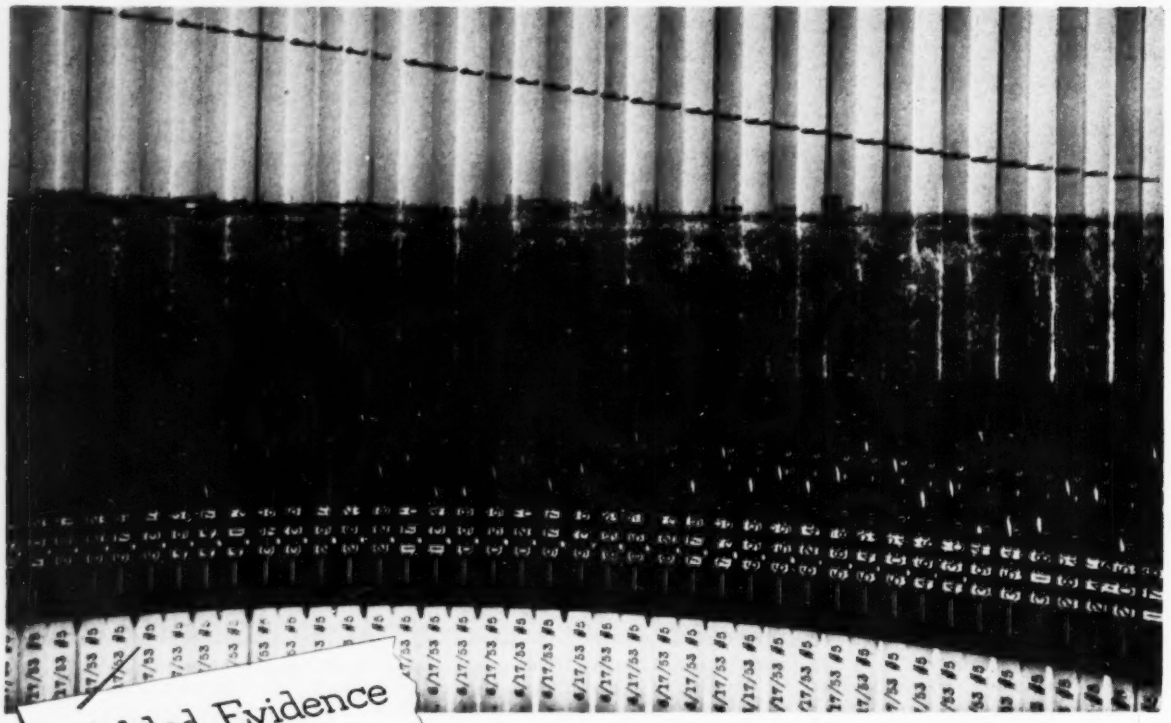
*Manufacturers suggested retail price.



SHOCK-RESISTANT CONSTRUCTION of the General Electric HP-3 pyrometer sustains accuracy with sturdy stationary parts, 3 1/4-lb. alnico magnet, and a lightweight moving element. ▶

For more information circle **39** on inquiry card.

Here's how to plot a plane's Angle-of-Climb...



Added Evidence that—

Photo by Sherman Fairchild & Associates' Flight Analyzer Camera, New York City

Everyone Can Count on VEEDER-ROOT

New take-off technique yields an 8° climb, as this progressive *single photo* shows. And this is 100% improvement over old techniques . . . increasing safety and decreasing noise-annoyance at city airports.

Here you actually see 53 separate exposures. And each, reading from bottom up, shows the date and number of the flight photographed. Next above is a device which records the time ...exact to 1/1,000th of a second. And in the heart of this device is a Veeder-Root Counter.

So here again you see one of the heretofore uncounted ways in which "Everyone Can Count on Veeder-Root". What's *your* problem? Let us put our mathematical eyes on it. Write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

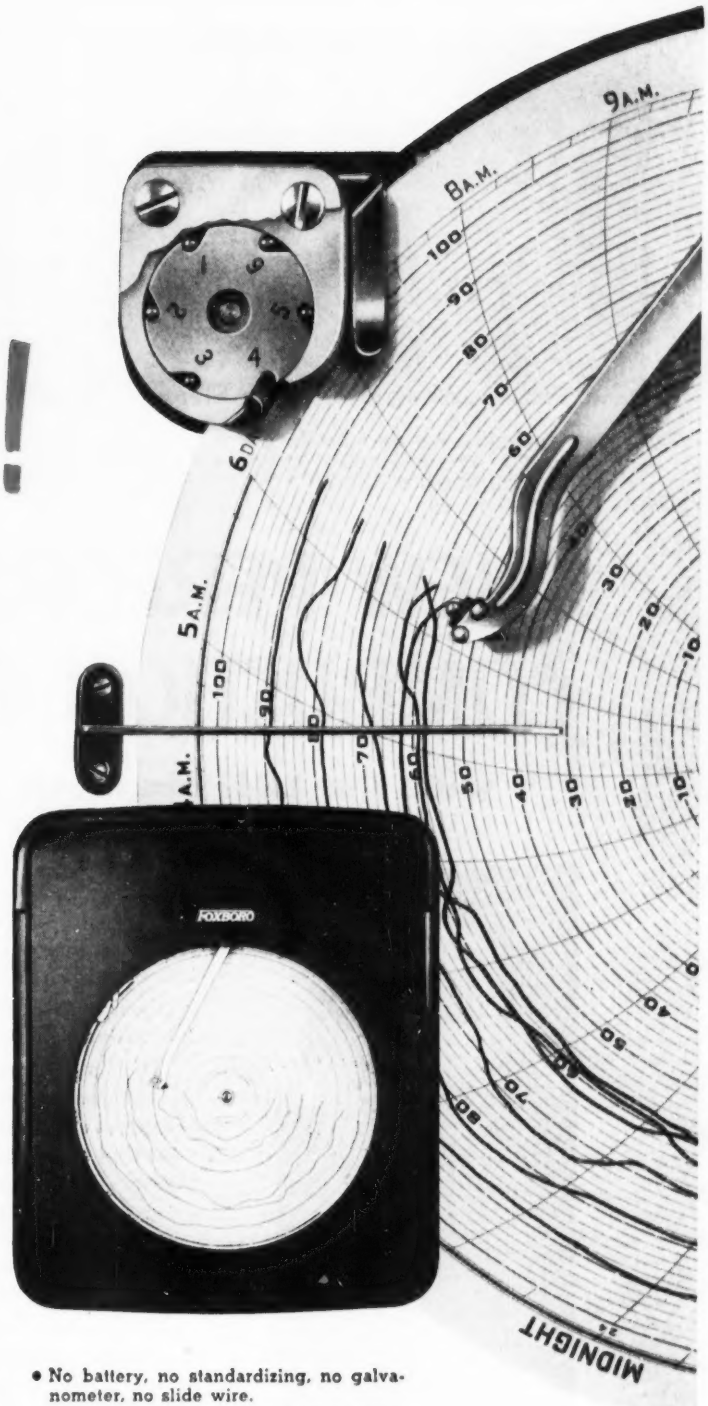
Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"The Name that Counts"

For more information circle **40** on inquiry card.

What a record!

...6 Color-coded Temperature Records on one ROUND Chart



THE MULTI-RECORD *Electronic* DYNALOG*

What convenience! What economy! You can record up to 6 related temperatures on a single *circular* chart with this Foxboro Multi-Record Dynalog. Not only saves panel space, but simplifies comparison of records. There's only one pen arm — yet all 6 records appear in different, distinctive colors. Bulletin 427-1 tells the complete story. (Bulletin 444 describes the Multi-Record *Pneumatic* Receiver). Write for your copy. The Foxboro Company, 4610 Neponset Ave., Foxboro, Mass., U.S.A.

*Reg. U. S. Pat. Off

Check these outstanding features

- High speed recording — only 6 seconds between prints for quick detection of process variations.
- Uses convenient, low cost circular charts.
- Each record line has its own distinctive, non-smudging color.
- No battery, no standardizing, no galvanometer, no slide wire.
- Unmatched accuracy, lowest maintenance, greatest convenience.
- Available with alarms or on-off control.
- Thermocouple or resistance-bulb types.

FOXBORO REG. U. S. PAT. OFF. — MULTI-RECORD DYNALOG

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

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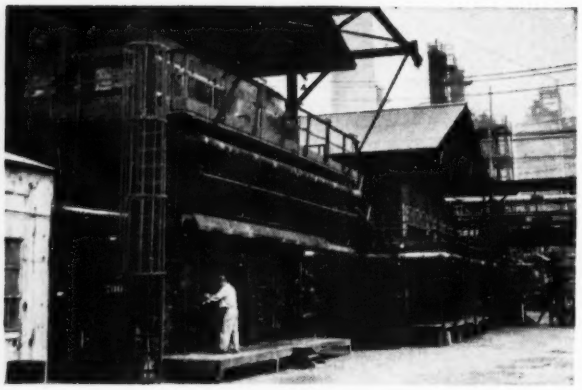
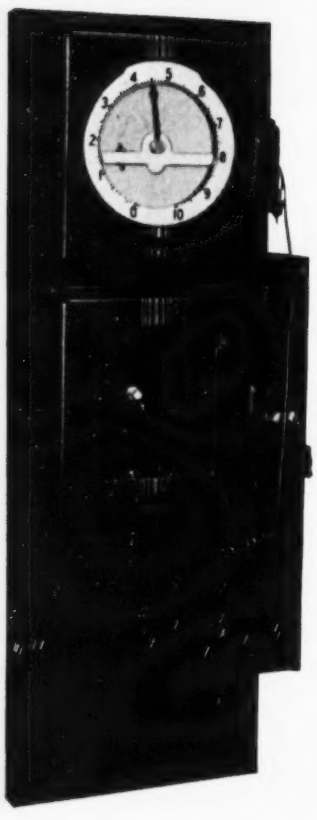


Typical plants where L&N oxygen recording equipment keeps total oxygen completely and accurately recorded, for more efficient combustion control.

Left: A steam central station (boiler furnace in rear) in an eastern utility. Right: A process heater in an eastern oil refinery.

NEW PERFORMANCE for COMBUSTION EQUIPMENT

with the L&N Magnetic Oxygen Analyzer



● Rugged, stable and precise, this unique analyzer detects the percentage of oxygen in flue gas from boiler furnaces and process heaters in oil refineries. Since oxygen is the most reliable index of excess air, especially when firing with mixed fuels, these desirable advantages are now made possible:

(1) combustion efficiency goes up (2) fuel costs go down, and (3) maintenance time is cut to the barest minimum.

To triply assure you of best results, Leeds and Northrup has teamed up this advanced instrument with the Speedomax® Recorder and a sampling unit experience-engineered for reliable operation. This efficient combination offers you this warranted and superior performance:

- **Calibrated Accuracy:** ± 0.15% oxygen against standard gas mixtures
- **Sensitivity:** Better than ± 0.05% oxygen
- **Stability:** Better than ± 0.15% oxygen
- **Speed of Response:** Initial—8 to 12 seconds; 90% of final reading—35 seconds

To revitalize your fuel-burning efficiency, remember that *L&N oxygen* equipment gives you . . . a rapid response to oxygen for *"tight" combustion control* . . . an accurate check on air with *no need for tank samples* . . . the most practical answer to *continuous, trouble-free operation.*

For further information, write to Leeds & Northrup Company, 4955 Stenton Avenue, Philadelphia 44, Pa.

LEEDS NORTHRUP

instruments automatic controls • furnaces

Jrl. Ad ND46-91(3)

For more information circle 42 on inquiry card.

Editorial Comment

How Automatic Can We Get?

"Our objective is a perfect product safely produced at minimum cost."

by H. F. DEVER
Brown Instruments Div.,
Minneapolis-Honeywell Regulator Co.

RESPONSIBILITY of sounding the technical keynote for a meeting of this nature is a formidable challenge. The accomplishments of the last decade, and presently occurring changes, amount to rapid evolution —if not a technological revolution—and one that cannot help but have a profound influence on the future of man.

How automatic can we get? Part of the answer lies in how much power is pushing us toward the goal of maximum automation.

A bulletin from DPA in Washington, released late in November, says in part:

> "Current production is at the rate of $1,300,-000,000 annually, or slightly more than the output of the large machine tool industry. This is about double the peak World War II output of scientific instruments, and two and one-half times the pre-Korea level, which was the highest achieved by this industry in peacetime. Some 1,000 firms produce the various instruments required by modern technology."

I submit that if interest and push will make us more automatic, we're going to get it from the manufacturers, if no one else.

Let us approach this subject on a practical basis. Our objective is a perfect product safely produced at minimum cost.

In our field, namely industrial recorders and controllers, sales represented about 1 to 3 percent of capital expenditures for machinery and equipment prior to World War II. The war stimulated developments and improved technology, with the result that in the last few years industrial instruments represent on the average about 7 or 8 percent of the capital expenditures for equipment in industrial plants.

Further education of both present and prospective users of instruments can expand this potential to 10 percent. Improved technology over the years will make instruments more usable, more valuable, more indispensable. Thus it is within reason to expect that some day 15 percent of capital expenditures for machinery and equipment will represent the fruits of our instrument technology, and that percentage would probably be applied to much larger expenditures as the economy grows.

There are plenty of directions to push back our present frontiers of technology. Technology is both our hope and our problem. How fast can we do these many challenging tasks? As usual, economics enters our picture, for even technology gets down to men and money, among other things. The point is that you and I look out on a vista of instrumentation problems crying to be solved rather than on a mature and stable situation in which technology has little or no place to go. It is not only possible but imperative that we develop the full potential of automatic control.

Miniaturization

If we are to use as much instrumentation as possible in an automatic age, we can see that the days of the so-called large and conventional instrument may be numbered. You are already seeing the first stages of miniaturization, generally in conjunction with another recent development—the graphic panel. Conventional instruments will probably be with us for a long time, but where we want more instruments on a job we find practical economic reasons why space must be saved, and that spells miniaturization. It may be that in 20 years we will have perfected automatic control so completely that we will not need to march up and down in front of a panelboard and watch gauges or recorders; scanning, computing, digital recording, and television may make the present panelboard obsolescent.

Electronics

Electronics has been a great contributing factor to the advance of instrumentation technology. The application of electronics in instrumentation is just beginning.

Looking at the process industries, it's apparent that we've been pneumatic-minded for many years; and with reason. Pneumatic controllers have been the work-horse in meeting our needs. Pneumatics have met the need, but what of the future?

Not all recent advances in control design have been confined to pneumatic systems. There have been broad developments in electrically operated controllers employing the latest electronic circuit improvements. We can now see *some* areas in which electricity *may* begin to push pneumatics to one side. It must be questioned whether or not pneumatic systems, with their inherent time lag, can ever satisfactorily fill the *more exacting* future requirements where quality criteria of the product must be instantaneously fed back into the control loop.

These comments are not a criticism of pneumatic systems; nor are these systems obsolete. Research and development effort on pneumatic systems must go on and will continue. Nevertheless, electronics or other forms of electrical means are going to become more prominent in the control and instrument field. Radioactive tracers, spectrophotometry, strain gauges, ultrasonics, and others forms of sensing elements are leading to greater emphasis on electricity. Magnetic amplifiers, transistors, hermetic sealing, and potting could make electrical systems just as safe as pneumatics—the problem may be primarily economic.

Computers

How automatic can we get? Before we attain the ideal of continuous measurement of the product quality and instantaneous corrective action in the process we must develop practical means for automatically integrating all necessary data by which we must maintain the desired quality. The answer to this coordination of control functions may lie in the use of computers.

Computers are too often pictured as enormously complicated "electronic brains." We have been using computers in our instrumentation for some time—witness our routine use of reset and rate action, ratio control, or cascade action.

Continued on page 1560

Keynote address before the Eighth Annual Symposium on Instrumentation in the Process Industries, Texas A & M College, College Station, Texas, January, 1953.

The Month's NEW INSTRUMENTS

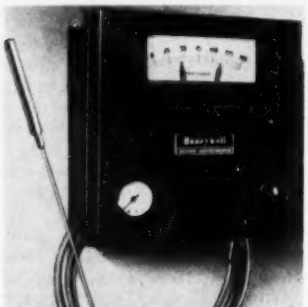
In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 1585

PROCESS CONTROL (and not otherwise classified)

Pneumatic Controller

New indicating pneumatic control thermometer is available either with direct- or reverse-acting "on-off" or



narrow-band proportional control units. Actuation is provided by standard vapor-pressure or mercury-filled thermal systems.—*Industrial Div., Minneapolis-Honeywell Regulator Co., Philadelphia 44, Pa.*

For more information circle **201** on inquiry card.

Numerical Indicator for Continuous Measurables

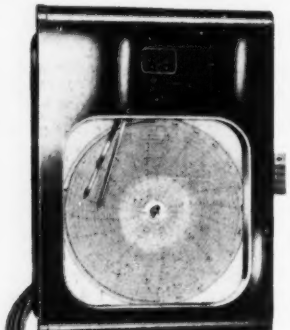
New "Miniature Numerical Indicator" provides direct reading of analog measurements; is geared to a servo-

motor; can be installed long distances from measuring point; can be used to measure velocity, temperature, light, and other variables; can also be used in conjunction with recording units in applications where continuous readings must be available to facilitate batching and processing operations, etc.—*Streeter-Amet Co., 4101 Ravenswood Ave., Chicago 13, Ill.*

For more information circle **202** on inquiry card.

Automatic Controllers

New "Free-Vane Electronic Controllers" are part of "Series 500" line; are available as indicating or recording controllers for temperature, pressure, flow, liquid level, humidity and time program control. They use maker's standard measuring ele-

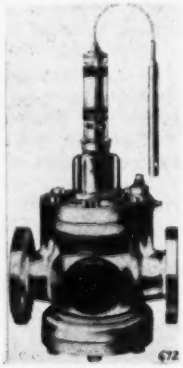


ments; operate on FM principle; are offered for low-open, high-open, low-high, low-open-high or low-normal-high control, as well as proportional-input control. Various combinations of one or two pens or indicators with one or two control units in one case.—*The Bristol Co., Waterbury 20, Conn.*

For more information circle **203** on inquiry card.

Temperature Controllers

New "Type V1000" direct-acting temperature controller for heating applications, and "VR1000" reverse-acting for cooling, are self-contained pilot-operated units using liquid-expansion principle. A single-seated pilot valve positions piston of main valve, which controls throttling position of the main valve disk. Sizes range from 2 to 4 in., for controlling temperatures from 25 to 275 F. through a 50 F. range. Maximum pressure 125 psig.



—*Farris Stacon Corp., 610 Commercial Ave., Palisades Park, N. J.*

For more information circle **204** on inquiry card.

Open-hearth Furnace Reversal Controller

New "Multi-Record Dynalog Rotax Controller" uses temperature measurements, by thermocouple or radiation units, as basis for open-hearth furnace reversal. Additional records of stack and steam temperatures (up

to six records) can be provided on same chart. Bull's-eye lights can be mounted on instrument or panel to indicate direction of firing. Reversal is initiated by either of two conditions: (1) when temperature difference between the two checkers reaches a pre-set value; (2) when temperature at either checker reaches a pre-set maximum. A timing reversal system can also be interwired so that automatic reversal can be actuated by pre-set temperature difference, elapsed time, or high temperature, whichever occurs first.—*The Foxboro Co., Foxboro, Mass.*

For more information circle **205** on inquiry card.

Magnetic Pickup

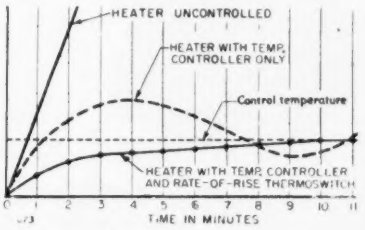
New "Model 3010-HT" is a small (2-in. long) mechanical-motion to electric-energy converter capable of operating at temperatures as high as

500 F. Teflon insulation used throughout. It operates without physical contact or "loading" when mounted near any moving magnetic material and generates a voltage output (up to 28 volts) proportional to rate of motion of any metal object with magnetic properties. It may be actuated by gear teeth, wheel spokes, or any vibration or displacement of magnetic material in its field. Units can be supplied for withstanding pressures up to 4000 psi.—*Electro Products Labs., Inc., 4501 N. Ravenswood Ave., Chicago 40, Ill.*

For more information circle **206** on inquiry card.

Rate-of-rise Thermostat

New "Rate-of-rise Thermoswitch," designed as safety control in fast warm-up systems, aids substantially in bringing system up to desired tem-


HEATER UNCONTROLLED
HEATER WITH TEMP. CONTROLLER ONLY
Control temperature
HEATER WITH TEMP. CONTROLLER AND RATE-OF-RISE THERMOSWITCH
0 1 2 3 4 5 6 7 8 9 10 11
TIME IN MINUTES

perature without danger of overshoot. When used in series with a temperature controller, it brings system up to temperature from a cold start, at any rate desired, without overshoot and oscillation; then standard temperature controller takes over and rate-of-rise unit becomes a safety check. Illustration shows difference in control during an initial warm-up period when a rate-of-rise unit is added to standard cycling and overheat controls. Enlargement of initial rising portion of curve with the rate-of-rise control would show a series of steps which gradually level off as control temperature is approached. Unit is adjustable to control any heating rate between 10 and 100 F. per minute, in any ambient temperature between —100 F. and 550 F.; is said to have excellent shock and vibration resistance; is hermetically sealed. Over-all length approx. 4.75 in.; stem diam. 0.625 in.; rating 5 amps. at 115 v.ac. or 2 amps. at 28 v.dc.—*Fenwal Inc., Ashland, Mass.*

For more information circle **207** on inquiry card.

Portable Tape Recorder

New portable tape recorder (made in England) is shoe-box size, operating on small batteries and a Garrard dual-spring flyball-governor tape-drive motor. Frequency response depends upon playback equipment; however it can be played back or monitored on itself. It uses standard U.S. batteries, tubes, tape, and a high-impedance microphone.—*Recorders Distributors, 7122 Melrose Ave., Hollywood 46, Calif.*

For more information circle **208** on inquiry card.

Weight or Thickness Gage

New basic mounting design for "AccuRay" radiation gages features a streamlined measuring head and a

tapered bracket, permits standardization of measuring systems, simplifies installation on production lines and provides easy access for servicing. Tapered bracket is available in throat

Circle **43** on inquiry card. →

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Examine for yourself every piece and component . . . consider the savings you realize through standardization and complete flexibility that only PANALARM "50" provides.

Then, evaluate *dependability*. Beyond all else, PANALARM "50" represents the greatest value in audio-visual alarm systems by its record of *dependable service* alone.

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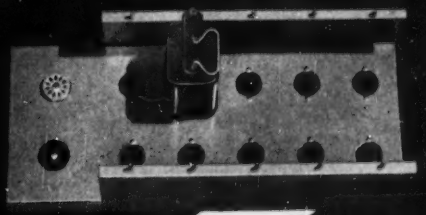
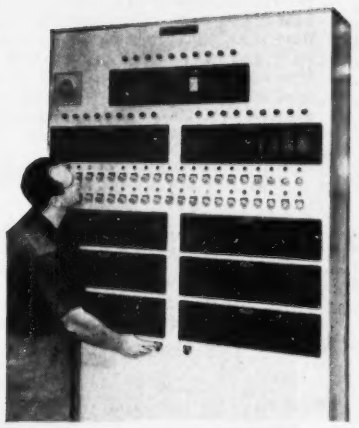
is interchangeable without re-wiring for all types of annunciator service: standard audio-visual; ringback; bullseyes or nameplates; trouble or running signals; lock-outs; or low drain operation.





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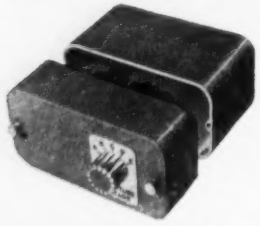
depths up to 160 inches. New variable-speed scanning mechanism enables gage to move slowly across sheet, while presenting a continuous profile picture, and then retract quickly to repeat scanning cycle. When gage withdraws, recorder pen remains stationary to mark beginning and end of each profile reading.—*Industrial Nucleonics Corporation, 1205 Chesapeake Avenue, Columbus 12, Ohio.*

For more information circle **209** on inquiry card.

Photomultiplier Attachment for Spectrophotometer

New photomultiplier attachment greatly increases sensitivity of maker's "Model B Spectrophotometer," is used in 30-600 millimicron range; permits measurement of low light levels in transmission and reflectance work; is similar to that now used on "Model DU Spectrophotometer" and operates directly from a-c amplifier of instrument (no batteries).—*Beckman Instruments, Inc., South Pasadena, Calif.*



For more information circle **210** on inquiry card.

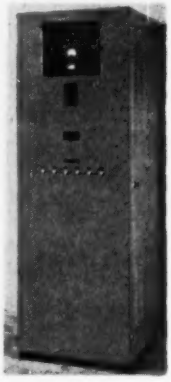
Tinplate Scale

New "Model #372-S Special Thermoseal Tinplate Scale," developed for use with relatively large pieces of material of relatively low weight, measures thickness of tin plate by a comparison of weight of steel sheets before and after plating; is designed around a Class III lever system. Platform is balanced by a counterweight so that a minimum tare weight is applied to the scale: necessary since weight of platform and levers far exceeds actual scale capacity. "Thermoseal" scale head automatically adjusts to zero over a wide range of temperatures. Capacity 50 oz. x ¼ oz. —*John Chatillon & Sons, 85 Cliff St., New York 39, N. Y.*

For more information circle **211** on inquiry card.

Six-point Combustible-gas Indicator and Alarm

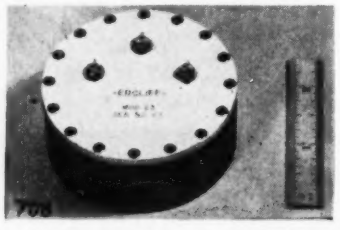
New "Model RV-6" indicating type combustible-gas alarm system performs sequential sampling of potentially explosive atmospheres from six locations. Model variations are available to permit sampling from any number of locations from two to eight. Unit draws samples continuously through metallic tubing and analyzes them point-by-point on a 30-second cycle (platinum-filament Wheatstone-bridge detection circuit). Combustible gas is indicated on a panel-mounted instrument, while sample line currently being analyzed is indicated on a series of pilot lights. If combustible reaches pre-set level, instrument stops cycling automatically, shows a red warning light, and actuates a remote alarm. This condition prevails until combustible is dissipated or corrective measures are taken. A push-button air-test control admits known pure air to analyzer for balancing circuit; and an arrangement draws continuous samples through all lines in system so that sequential analysis is always performed on fresh samples.—*Johnson-Williams, Ltd., 2613 Third St., Palo Alto, Calif.*



For more information circle **212** on inquiry card.

Inclinometric Pickup

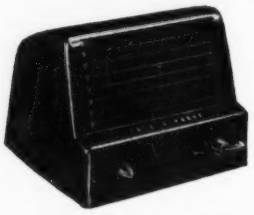
New "Model C3 Pendulum Position Indicator" is a fluid-damped transducer for indicating angles of inclination up to plus or minus 45 deg. It contains a pendulous mass which operates a precision variable resistor. Among its characteristics are: Friction error (static) less than 1.5 deg., 2 deg. with vibration; resolution 0.1 deg.; zero backlash. Resistor winding is normally supplied at 2000 ohms and linearity at 0.5 percent. Fluid damping at 0.6 critical. Other values of resistance and damping, also center taps, available on request.—*Edcliff Instruments, 383 No. Foothill Blvd., Pasadena 8, Calif.*



For more information circle **213** on inquiry card.

Industrial Intercom

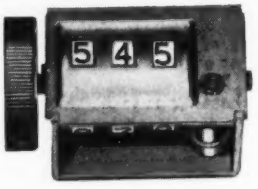
New "Talk-A-Phone LC-33" is a "wireless" two-station intercom system: it requires no wired installations, can be plugged into any electrical outlet, is designed for locations where instant or temporary installation is desired. Users can talk between offices, plants, etc., moving units from place to place as needed. Feature is "Sonic Gate" circuit which suppresses line noises and hum.—*Talk-A-Phone Co., 1512 S. Pulaski Rd., Chicago, Ill.*



For more information circle **214** on inquiry card.

Tape-position Indicator

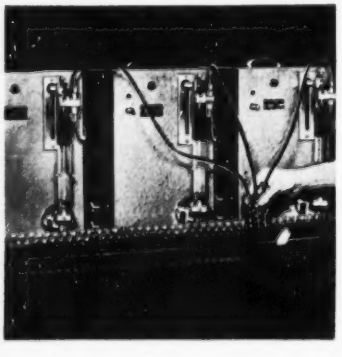
New "Productimeter," developed for tape recorder manufacturers, indicates position of tape at any time during recording or play-back cycle. Special gear ratios are furnished so that counter indicates feet. Counter is reset to zero, by knob at left, when a new tape is placed in recorder.—*Durant Mfg. Co., 1914 No. Buffum St., Milwaukee 1, Wis.*



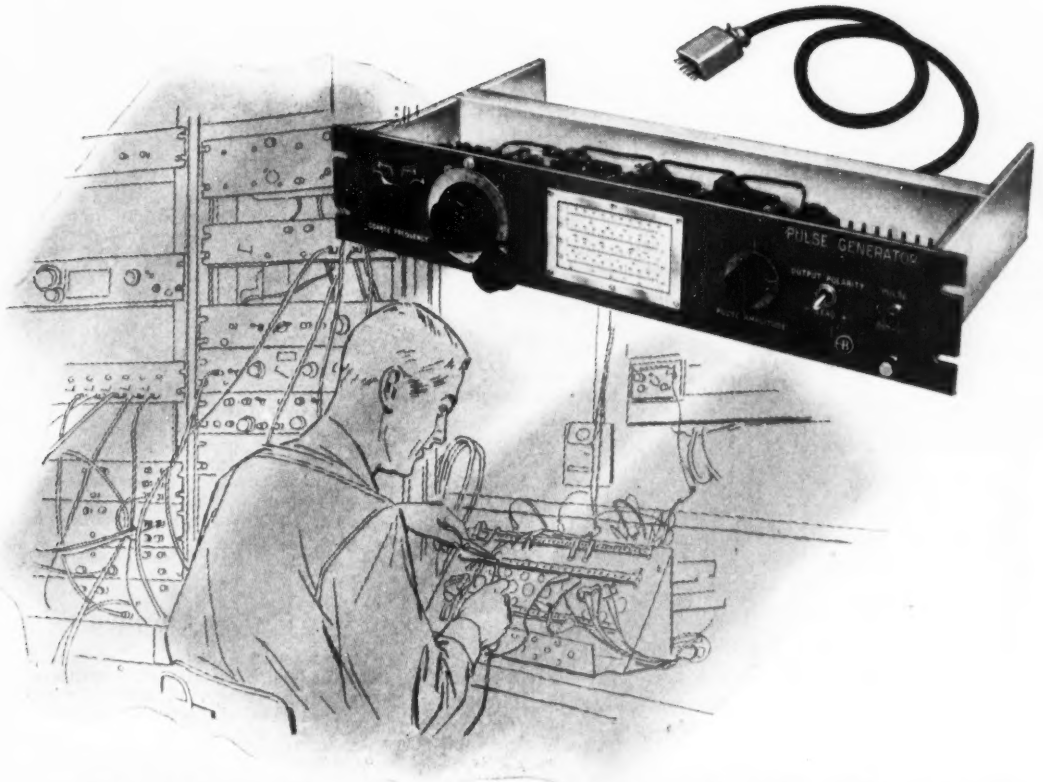
For more information circle **215** on inquiry card.

Automatic Vial Filler

New "Filamatic Add-A-Unit" is a multiple type positive-displacement vial filler: any number of "Add-A-Units" may be operated together in tandem for high-speed filling of vials and small containers up to 4.5 oz. in size. Oils, suspensions, concentrated solutions and aqueous solutions are handled with equal facility. All units operate in synchronization, and removal of any unit for servicing does not affect operation of others. Any desired production rate can be attained by adding units as required: three-unit set-up shown fills 50,000 1-oz. vials per 8-hour day. Only one operator required regardless of num-



FOR APPLICATIONS IN RADAR, TELEMETERING, DIGITAL COMPUTING, TELEVISION, NUCLEAR PHYSICS



"Unitized" Pulse Control Equipment

saves engineering time and money

WHEN you use Burroughs "Unitized" Pulse Control Equipment, you eliminate much of the costly, time-consuming work of developing electronic test circuits. There is a Burroughs pulse control unit for practically every basic function in pulse circuit engineering. You need only plan a block diagram of the pulse circuits you want, assemble the necessary Burroughs units in the plug-in rack and interconnect them with the various standard coaxial cables and accessories. This can be done because each unit performs *one basic operation* such as generating, counting, mixing, gating, or delay.

JUST "PLUG IN" A BURROUGHS PULSE GENERATOR

Any of the three pulse generators offered by Burroughs demonstrates the practical one-basic-function principle behind Burroughs "Unitized" Pulse Control Equipment . . . you simply select the pulse generator for the job and plug in the cables.

Burroughs Pulse Generator, Type 1002B, generates 0.1 microsecond pulses at frequencies continuously variable from 0.2 megacycles to 4.5 megacycles in four overlapping bands. A calibrated, L-C controlled, sine-wave oscillator controls the frequency. Output amplitude, which is only affected by frequency changes in the ranges above 2 megacycles, can be varied from 10 to 32 volts and the polarity of the output pulse is reversible.

Like other Burroughs units, this pulse generator is designed and engineered so that it can be added to equipment now in use, selected as a basic component of new equipment, or used repeatedly for testing or as a component in future pulse control jobs.

For full information on Burroughs "Unitized" Pulse Control Equipment, write or call Department 15D, Electronic Instruments Division, Burroughs Corporation, 511 N. Broad St., Philadelphia 23, Pa.

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COINCIDENCE DETECTORS
PULSE DELAY CIRCUITS
FLIP-FLOP CIRCUITS
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For more information circle **44** on inquiry card.

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For Cyanide and Salt Baths

Gordon Type R tubes, made and specially treated for use with thermocouples in cyanide and salt baths, not only give greater protection by preventing detrimental gas infiltration and penetration, but also have unusually long life in service. Join the many satisfied users and lower your tube replacement costs.

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This is only one item in Gordon's complete line of protecting tubes for practically every application. Over a million of them have been put in service in the past few years. No matter what your requirements in protecting tubes are, both in regular and special size, consult Gordon first.

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For more information circle **45** on inquiry card.

NEW INSTRUMENTS

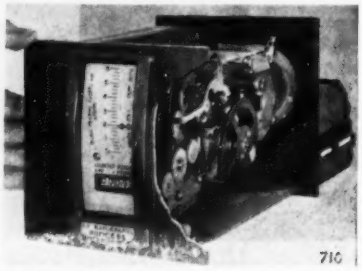
ber of units. Volume delivered by each unit can be adjusted with micrometer accuracy independently of other units. Entire filling mechanism of each unit can be removed for steam sterilizing. Pistons can be furnished in stainless steel or glass as desired. Synchronizing mechanism and motor control are electronic.—*National Instrument Co., 5005 Queensbury Ave., Baltimore 15, Md.*

For more information circle **216** on inquiry card.

F L O W

Integrator-Indicator

New "Miniature Integrator-Indicator" incorporating a full-size integrating mechanism and standard 5-digit counter is added to maker's series of



710

"Ratographic" instruments. High-speed integrating unit senses and totals flow-rate 24 times per minute so that varying flows are totalized to accuracies within 1 percent of full-scale; makes totalizer responsive enough to take full advantage of sensitivity of flow-rate meters. Totalizing mechanism is oil-immersed. Instantaneous flow-rate is indicated on a vertical strip by a pointer attached to integrator calibration cam. Pointer is positioned (with cam) by a pneumatic receiver which operates at signal pressures of from 3 to 15 psig. Another new feature is heavy-duty 100-rpm synchronous motor which establishes timing base for integrator; its low speed eliminates delicate high-speed gear trains. Instrument may be combined with an impulse-type counter to operate shut-off or other end-point control devices.—*Fischer & Porter Co., 15 Jacksonville Road, Hatboro, Penna.*

For more information circle **217** on inquiry card.

Jet-fuel Mass-flow-rate Remote-indicating System

New mass flowmeter system for accurately measuring fuel consumption rate of jet aircraft engines indicates fuel flow in pounds per hour, eliminating fuel density errors; consists

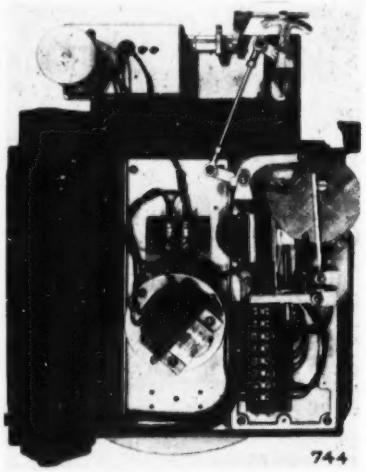
713

of a constant-frequency power supply, a transmitter, and an expanded-scale indicator located on pilot's instrument panel. For multi-engine aircraft, power supply operates up to eight transmitters and indicators. Transmitter (illustrated) consists of two identical cylinders placed end to end. Around periphery of upstream cylinder, which is rotated by a constant-speed drive, a number of equally-spaced holes are placed. Fuel moving down pipes enters these holes, which change its momentum by reason of angular velocity. As second cylinder removes this angular momentum, it is deflected against calibrated springs. Angular deflection (a direct function of mass-flow-rate) is transmitted to indicator. Conductive and radiative radio noise is kept within MIL-1-6181 limits. All critical components are internally shock-mounted. Low-pressure-line off-engine mounting of transmitter is made possible by transmitter's extremely low pressure drop. Transmitter measures up to 12,000 pounds per hour, operates with fuel of any temperature from —55 C. to 70 C.; is approx. 10.5 in. long. Indicator is about 2 in. in diameter. Total system weighs about 11 lbs.—*General Electric Co., Schenectady 5, N. Y.*

For more information circle **218** on inquiry card.

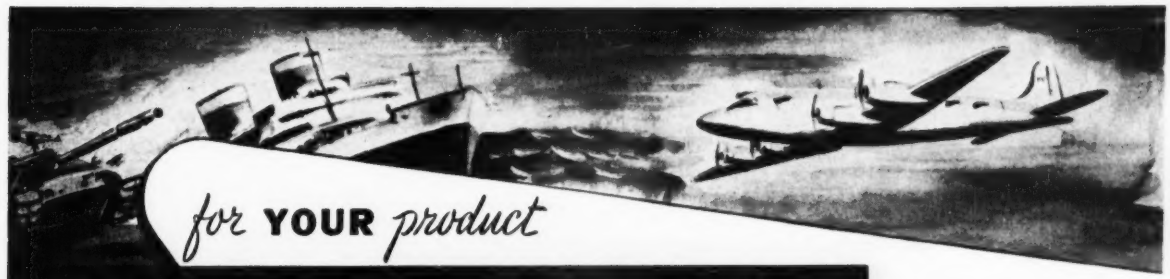
Mercuryless Flowmeter

New flow-rate meter makes use of mercuryless bellows-type transmitters, is available in several different models for indicating, recording and with



744

a continuous type mechanical integrator or combinations thereof for measurement of flow of steam, water and other fluids. Records of air flow for boiler operation and pressures and temperatures can be combined in one instrument. Transmitters are rupture proof type for differentials of 20 to 750 inches of water; standard static operating pressure 1500 psig.; higher pressure ratings can be supplied. Liquid-level transmitter is of buoyant-float-operated type with torque tube assembly. Transmission system employed between transmitter and recorder makes use of differential transformers and a null balance a-c. system independent of line voltage variations. Six-digit integrator is continuous in operation; no integrator creep at zero;



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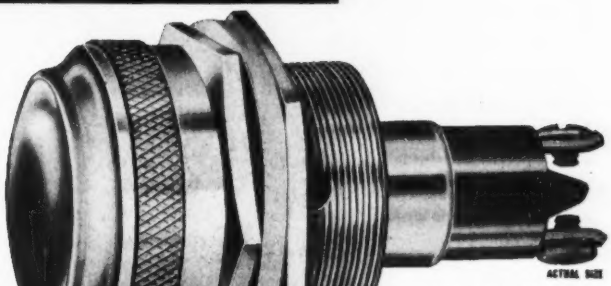

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The miniaturization program on defense products required the development of this *sub-miniature* light. It is used on communication equipment and aircraft. Midget flanged base bulbs to fit are rated 1.3, 6, 12, and 28 volts.

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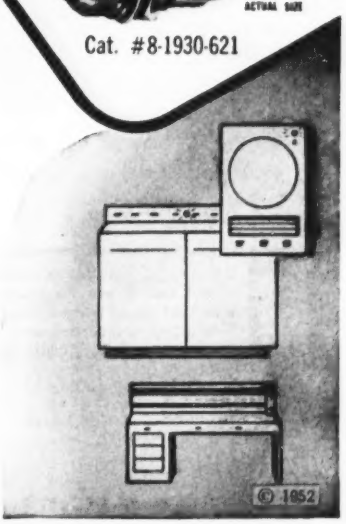
Samples to suit your own special conditions and requirements will be sent promptly and *without cost.* Just outline your needs. Let our engineering department assist in selecting the *right lamp* and the *best pilot light* for YOU.



Write for the Dialco HANDBOOK of PILOT LIGHTS

Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

60 STEWART AVE., BROOKLYN 37, N. Y. HYACINTH 7-7600

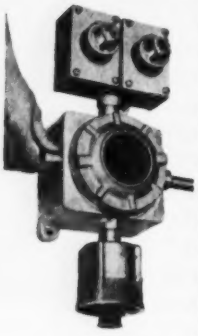
For more information circle **46** on inquiry card.

DETECT combustible GAS

INDICATE • RECORD • CONTROL

MODEL F

J-W Model F indicator checks the presence of combustible gas at inaccessible locations. Aspirator bulb draws air mixture through sampling hose and probe. Meter registers combustibility instantly. Fully portable, dry-cell operated.



MODEL EE

J-W Models E and EE Alarms monitor fixed installations where explosive hazards may exist. For continuous operation from standard 115-v a-c line. Actuate audible or visual signals, control valves or motors. Model EE is explosion proof. Model E is for installation remote from sensing unit.

SENTINEL

J-W Sentinel Alarm serves as a fire-danger watch-dog under conditions of special localized combustible-gas hazard—such as: welding, electrical work, tank cleaning, etc. Storage-battery operated, inbuilt charger, penetrating audible alarm.

Other models available for laboratory, oil-well logging, and other specialized uses. Your inquiry is invited on designs to meet particular requirements.

Standard for over 25 years

Write for complete information

JOHNSON-WILLIAMS, Ltd.

PALO ALTO 3, CALIFORNIA

For more information circle **47** on inquiry card.

easy micrometer zero adjustment; indicators can be calibrated to read directly.—*The Hays Corp., Michigan City, Indiana.*

For more information circle **219** on inquiry card.

PRESSURE

Low-pressure Pickups

New "Model L Low Pressure Transducers," available in standard ranges of 0 to 4, 8, 15 and 20 psi., utilize a unique design of bellows, beryllium-copper flexure member, and wire-wound voltage-dividing resistor, without linkages or pivots. Electrical and pressure fittings project from one face of unit. In gage-pressure and differential pressure types, volume displacement is minimized by unique design; in "Baropot" (for altitude or barometric work) bellows units are evacuated and sealed.—*Servonic Instruments,* 1193 *W. Second St., Pomona, Calif.*

For more information circle **220** on inquiry card.

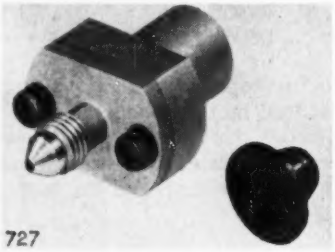
Vacuum Leak Detectors

New "Junior Vacuum Leak Detectors" are designed for bench location and are supplied with vacuum pump built into unit or engineered to fit application. Units are offered in manually-operated, semi-automatic, or automatic models, for laboratory and random testing, or production testing with green and red lights. In some applications, new equipment can be made completely automatic. Other units indicate rate-of-leak in measuring flatness of highly-finished surfaces.—*Whittington Pump & Engr. Corp.,* 1126 *Prospect St., Indianapolis 3, Ind.*

For more information circle **221** on inquiry card.

Pressure-instrument Protectors

New "Pressure Instrument Isolators" protect delicate pressure instruments from corrosive atmospheres and liquids, are inserted in pressure lines.



727

Volume-containing portion of isolating diaphragm is filled with a transmitting fluid and coupled to instrument. To minimize pressure drop, pressure is applied to tend to collapse cone-shaped 0.008-in.-wall diaphragm. Two sizes: 0.25 and 0.70 cc. Various materials available.—*Servonic Instruments,* 1193 *W. Second St., Pomona, Calif.*

For more information circle **222** on inquiry card.

TIME

Time-operation Recorder

New "Operational Recorder" is driven by a synchronous motor, produces a continuous record on a 24-hr.-rotation 7-day chart (spiral). Stylus

718

is capable of tracing three positions. Middle position, for example, indicates normal pressure, temperature, etc.; second position indicates a deviation above normal; third, below normal. Among suggested uses: monitoring unattended pumping stations, etc.; time-variable recording of automatic-control systems; recording machine down-time; production control; time study analyses; and meteorological applications.—*Librascope, Inc.,* 1607 *Flower St., Glendale, Calif.*

For more information circle **223** on inquiry card.

Time Switch

New "3000 Series Memory Master" time switch, replacing "300 Series," is said to be completely new inside and out. "Torsion clutch" dial drive allows for free movement of dial, permitting manual check of on-off switching operations. Dial trippers need only be loosened slightly for resetting. Additional trippers can be added quickly without removing dial to provide for 16 operations per 24-hour period. Contacts feature oversized silver contacts. "Moto-Vu" window in motor-mounting plate permits instant check of motor operation. Complete movement can be removed from case by loosening one screw. Unit is UL approved for 30-amp. capacity at 120 or 240 volts.—*Paragon Electric Co., Two Rivers, Wis.*

For more information circle **224** on inquiry card.

Elapsed and Pre-set Time Indicator

New "Model 2D Nuclear Timer," designed for radiation counting and nuclear research, integrates total time from 1 second to 60 minutes regardless of periodic starts and stops. Accuracy 0.1 second. Dual dial markings permit direct reading of pre-set and elapsed time. Switching mechanism

NEW AMERICAN® TELECOUNTERS for base volume indexes

Now you can read base volume indexes at any remote location

American Telecounters accurately transmit Base Volume Index indications of gas quantities, computed to base temperature and base pressure conditions, to any convenient reading station. Remote indications are read from a compact reset-type counter which installs anywhere. The counter is actuated by electrical impulses received from the transmitter housed in the explosion-proof case on the side of the Base Volume Index.

- **Reset-Type Counter only 1⅝"x 4"**
- **Explosion-Proof Transmitter Case**
- **Adapts to Large Capacity Ironcase Meters**
- **Reliable Transmission At All Times — Leased Wire, Private Wire Or Radio**
- **Power Pack Operates from Commercial 110 Volt, 60 Cycle, Single Phase Power Supply**

GENERAL SALES OFFICE: 1513 Race Street, Philadelphia
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AMERICAN METER CO. EST. 1820

AMERICAN® METER COMPANY
INCORPORATED (ESTABLISHED 1820)

For more information circle 48 on inquiry card.

PALMER

MERCURY ACTUATED

Temperature Indicating Instruments

4½" DIAL THERMOMETERS

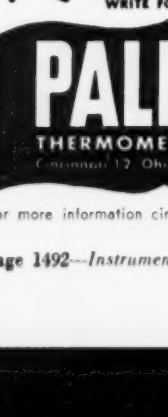
Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

RECORDING THERMOMETERS

Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

INDUSTRIAL THERMOMETERS

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.



RED-READING MERCURY LABORATORY THERMOMETERS

Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

FOR COMPLETE INFORMATION WRITE FOR CATALOG 200 G

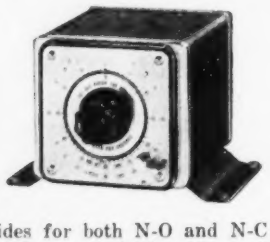
PALMER

THERMOMETERS, INC.

Cincinnati 12, Ohio • MElrose 1500

For more information circle **49** on inquiry card.

NEW INSTRUMENTS



provides for both N-O and N-C circuits. Four standard motors: 115-v. 50 or 60 cps., 230-v. 50 or 60 cps.; special motors on order.—*The Liebel-Flarsheim Co., Cincinnati* 15, *Ohio.*

For more information circle **225** on inquiry card.

COMPUTING

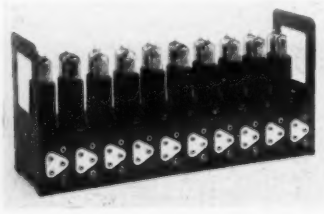
Digital Computer

New "Magnetic Drum Calculator" is a commercial electronic decimal calculator for accounting and computing requirements between those met by maker's "giant brains" and those met by maker's smaller machines such as "604" and "Card-programmed Calculator." It can incorporate in one machine operations in punched-card accounting which once required several machines. It has up to 20,000 memory positions and can accept up to 2,000 individual operating instructions to facilitate commercial and scientific computations. It consists of a magnetic drum unit with electronic calculating components, an input and output unit, and a converter (not visible in photo). Among features is a "Table Look-up" operation which facilitates automatic searching of rate tables as in utilities, insurance, etc. In addition to performing all computations for billing customers, remaining drum capacity can be used for distribution of revenue or rate statistics: cumulative information may be kept on drum as long as desired, regardless of disposal of data used in individual billing. By means of console, operator has control over all stages of calculations and may manually insert instructions or data into any desired storage location, examine contents of these locations, stop calculation at any required point and begin calculation with any desired instruction located in memory unit.—*International Business Machines Corp.,* 590 *Madison Ave., New York* 22, *N. Y.*

For more information circle **226** on inquiry card.

Analog Computing Unit

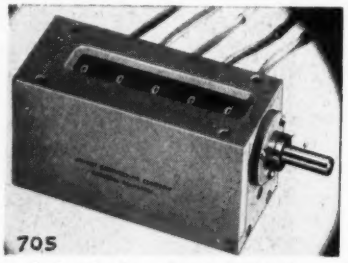
New "Model HK Operational Manifold Component" comprises a set of ten "Model K2-W Operational Amplifiers" plugged into a special chassis to provide a basic electronic-analog facility. All common service connections to amplifiers are provided. Zeroing means of improved stability are accessible at front. A new symbolic arrangement of computing connections is featured, whereby circuit elements and input and output leads are readily plugged-in to form feedback circuitry. These and several other features are claimed to result in efficiency and flexibility not hitherto available in analog operations.—*George A. Philbrick Researches, Inc.,* 230 *Congress St., Boston* 10, *Mass.*



For more information circle **227** on inquiry card.

Counters for Computing and Telemetering

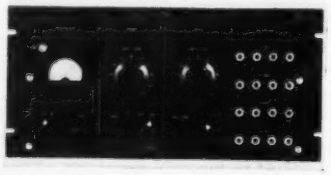
New "Digipot" and "Digicon" mechanically-geared decade counters have telemetering applications for registering variables such as physical positions, servo-actions, and for totalizing pulse inputs. (1) "Digipot" is for analog-digital recordings or data computation by use of divider networks: resistors on each digit-wheel provide a voltage division proportional to number visually indicated by mechanically-coupled wheels; visual indication of stored number, combined with voltage contact signals, provides appropriate method to correlate photographic data with electrical recording methods. (2) "Digicon" is designed with 10-ma. contacts in ten positions around each decade of counter wheels. Both "Digipot" and "Digicon" are available with either 3 or 5 decades; meet requirements of flight operation such as wide temperature ranges and high shock or vibration conditions up to 10 *G.* Stepper motors for actuation of new units are available so that pulse inputs may be stored, read, or recorded.—*Wright Engineering Co.,* 180 *East California St., Pasadena* 1, *Calif.*



For more information circle **228** on inquiry card.

Analog Stimulus Generator

New "Model CS Central Signal Component" is for use in high-speed repetitive analog computing systems to initiate time-solutions and otherwise to assist in organizing, operating, and calibrating such systems, as well as in display of their results. A fixed time base of 20 cps. affords a 40-



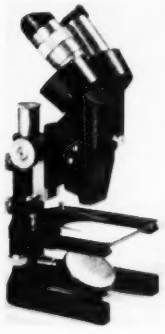
millisecond computing interval. Three kinds of signals are available, all internally synchronized: (1) "clamp" holds a system artificially stabilized prior to stimulation; (2) "ramp" provides a linear time-base, covering entire 50-millisecond interval, for plotting and scanning purposes; (3) "step" is automatically delayed following removal of "clamp," is adjustable from 0 to 50 volts positive or negative, and may be retracted to form a square pulse of 0 to 30 milliseconds width. Included is a binary reversing system which will optionally alternate between positive and negative step stimuli on a 10-cycle base.—*George A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.*

For more information circle **229** on inquiry card.

OPTICS

Stereoscopic Microscope

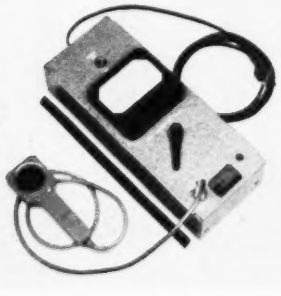
New "Model DPG" stereoscopic microscope has three new features: (1) a 180-deg. rotating binocular head inclined at a 30-deg. angle and turning on a vertical axis to permit either normal or inverted observation. (2) A "three-way" stand which, when completely set up, sits extra low for user comfort; large specimens can be observed in this arrangement as microscope will accept objects up to 11 cm. in height; since column of "DPG" retracts into base, changes are made simply by extending or lowering column; third way is for close-up inspection of specimens: base support removed by unscrewing two knobs and unit placed directly on object to be examined. (3) Novel nosepiece for almost automatic quick change of observation with the three matched pairs of parfocal objectives supplied.—*Opplem Co., Inc., 352 Fourth Avenue, New York 10, N. Y.*



For more information circle **230** on inquiry card.

Low-level Light Meter

New "Low Level Illumination Meter" was originally designed for calibration of other light-measuring apparatus; is said to "assure absolute accuracy in quantitative measurement



Precision WHEATSTONE BRIDGES

Highest Accuracy. . . Minimum Size for Field, Lab, and Production Use

There's a Shallcross Bridge for measuring resistance to any desired precision—indoors or out. Field models have aluminum cases with controls easily adjustable even with a gloved hand. Models for lab, production, and school use feature high readability and simple operation—even for unskilled users.

Accuracy, Stability, and Ruggedness—unsurpassed in any instrument of comparable price.

Selections from the complete Shallcross line are described below. Additional specifications on these, and many other types, are available from SHALLCROSS MFG. CO., 510 Pusey Ave., Collingdale, Pa.

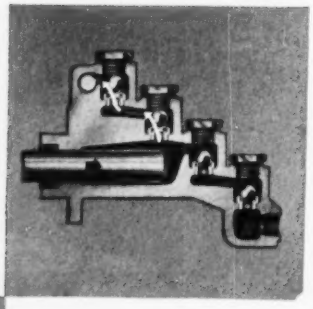
WHEATSTONE—FAULT LOCATION BRIDGE No. 6100: 5-dial field model. Locates grounds, crosses, opens, and shorts by Murray, Varley, Hilborn, or Fisher Loop and Capacitance tests. Range: 1 to 1,011,000 ohms. Accuracy: ± 0.1%, + 0.01 ohm. 8⅞" x 7⅜" x 5¾". 8 lbs. *Price: $175.*

KELVIN-WHEATSTONE BRIDGE No. 638-R: Shallcross has pioneered this compact combination of two bridges in one. Range: 0.001 to 11,110,000 ohms. Accuracy: ± 0.3% − 1 to 111,100 ohms. 12½" x 10½" x 6¾". 9 lbs. *Price: $260.*

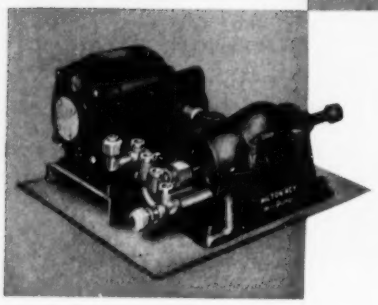
WHEATSTONE-LIMIT BRIDGE No. 6320: Combines 5-dial Wheatstone and Percent-Limit features. Range: 0.1 to 111,110,000 ohms. Accuracy—*Ratio resistors:* ±.01%, *Rheostat:* ± (.01% to .05% + .005 ohms). 15¾" x 9¼" x 5½". 15 lbs. *Price: $700.*

Shallcross

For more information circle **50** on inquiry card.



——the discharge stroke of the Milton Roy Controlled Volume Pump. Forward thrust of plunger lifts discharge double ball-checks and displaces metered quantity of liquid. Suction ball-checks are positively seated. Sloping passages and absence of pockets assure discharge of entrained air, to maintain high and reproducible volumetric efficiency.



Fifty Per Cent Time Savings with this Milton Roy Pump

CONTROLLED VOLUME PUMPING

INSTRUMENTATION

PROCESS CONTROL SYSTEMS

BLENDING AND FORMULATING

On The Job in an Eastern manufacturing plant, this Milton Roy "miniPump" replaced a costly hand process, wherein *one tenth of a milliliter* of liquid was added to open cells on each stroke of the pump. The switch to automatic continuous injection with this pump cut production time in half, gave much greater accuracy.

Such efficiency in the precise metering of minute quantities of any clear liquid is merely one reason why "miniPump" is so widely used in industry. This pump has application in laboratories . . . in pilot plants . . . for full-scale production operations . . . in instrumentation, continuous processing. As air-powered or motor-driven units, they operate within the capacity range of 3 to 3,200 milliliters per *hour*, against pressures to 1,000 pounds per square inch. Accuracy is maintained within 1%.

This precision instrument is the miniature member of the family of Milton Roy Controlled Volume Pumps which range in capacity up to 45 gallons per minute, against pressures up to 25,000 pounds per square inch. They are available as single or multiple units, or as component parts of complete chemical feed and control systems.

***Bulletin No. 653** describes "miniPump", its design, construction, uses. Write **today** for your **free** copy.*

Engineering Representatives in the United States, Canada, Mexico, Europe, Asia, South America and Africa.

MILTON Roy COMPANY

Manufacturing Engineers

1399 E. MERMAID LANE • PHILA. 18, PA.

CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

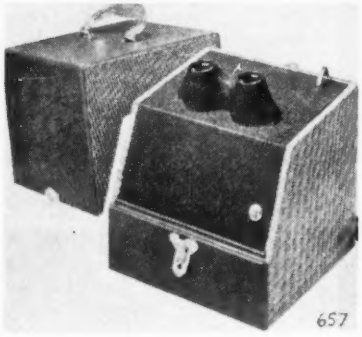
For more information circle **51** on inquiry card.

of light as low as 0.005 foot-candles." Features: drift-free amplification of output of barrier-type photocell; logarithmic scale 0.005 to 100 foot-candles and any decimal multiple; no damage from sudden exposure of photocell to high intensity; calibration unaffected by replacement of any component other than calibrating resistors; instrument ready for use after 30-sec. warm-up; various configurations of probe available in addition to the one shown in photo.—*Specialties, Inc., Skunks Misery Rd., Syosset, L. I., N. Y.*

For more information circle **231** on inquiry card.

Stereoscopic Viewer

New "Stereomatic Viewer" is said to produce a realism in a stereo transparency "unequalled in any other 3-D viewing or projection device." Two



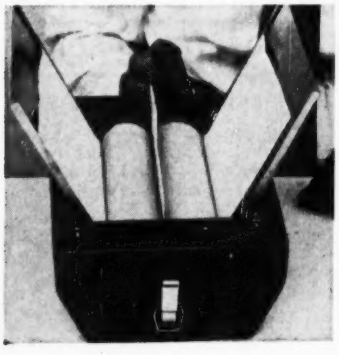
models are offered, both internally illuminated and operating on 110 v.ac. Both show a series of 12 slides. Automatic model shows entire series with an interval of some seconds between each slide; can be re-actuated through complete cycle by again pressing starter button. In semi-automatic model, actuating button must be pressed for each change of scene.—*Burke and James, Inc., 321 S. Wabash Ave., Chicago 4, Ill.*

For more information circle **232** on inquiry card.

PHOTOGRAPHY, ETC.

Positive Processor

New "Constat Portable Dry Processor" makes ready-to-use positive copies of anything that has been photo-copied. Process requires less than



20 seconds, according to manufacturer. Machine is made of stainless steel and chip-proof fiber-glass; was designed to be used primarily with "Contoura Portable Photo-Copier" but will work with any photo-copier. Dimensions 6 x 12 x 4 in. high; weight 8 lbs.; no electrical or plumbing connections.—*F. G. Ludwig, Inc., Deep River, Conn.*

For more information circle **233** on inquiry card.

Microfilm Camera

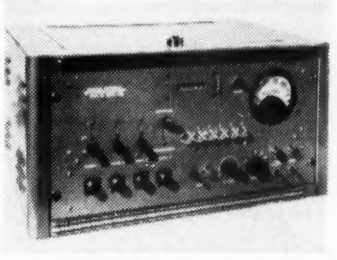
New "Model 4 Film-A-Record" permits single pages, or series of pages stapled together, to be microfilmed without removing and replacing staple. It handles bound volumes with pages spread open, magazines, notebooks, etc., up to 11 x 17 in. Visual Supply Indicator shows amount of film left in camera; audible signal warns operator when film has been loaded improperly, when take-up reel is full, or when film fails to advance properly. Foot switch controls photographing document and advancing correct amount of film. —*Remington Rand Inc., 315 Fourth Ave., New York 10, N. Y.*

For more information circle **234** on inquiry card.

NUCLEONICS

Coincidence-anticoincidence Scaler

New "Model 400" coincidence-anticoincidence scaler is self-contained, offers utmost versatility: all four channels may be used for coincidence counting with fourth channel also designed specifically for anticoinci-



dence counting. Channel dead time is less than 10 usec.; counter voltage is continuously variable from 500 to 2500 volts, with regulation of 0.01 percent per 1 percent change in line voltage.—*Radiation Instrument Development Laboratory, 2337 W. 67th St., Chicago 36, Ill.*

For more information circle **235** on inquiry card.

Portable Scaler

New "Model 2080" battery-operated portable scaler, for measurement of extremely low beta or gamma radiation levels where source-to-background ratio is small, is said to make it possible to obtain high accuracy in field measurements where conventional

STABLE AS A
Wirewound
RESISTOR*
SIE
MODEL "R" VOLTMETER

• DC VOLTS • DC MILLIVOLTS
• AC VOLTS • AC MILLIVOLTS
• STANDARD CELL • DC AMPLIFIER
• OHMS — MEGOHMS

THE MODEL "R" VOLTMETER

The Model "R" is primarily intended for the precise measurement of DC potentials, providing DC voltage ranges from one volt full scale to 1,000 volts full scale, however, to allow the instrument its greatest possible utility, the following auxiliary functions have been included in its design:

Distortionless DC Voltage Ranges: Reads and 99% of measured voltage and indicates 1% of measured voltage full scale.

DC Millivolt Ranges: One millivolt full scale to 1,000 millivolts full scale.

AC Volt and millivolt Ranges: One millivolt full scale to 1,000 volts full scale from 10 cps to 100 kc.

Self-Contained Standard Cell: For instant check of voltmeter calibration.

Ohms Ranges: Times one to times 10⁶.

Extended Ohms Ranges: Reads beyond half of ohms scale full scale.

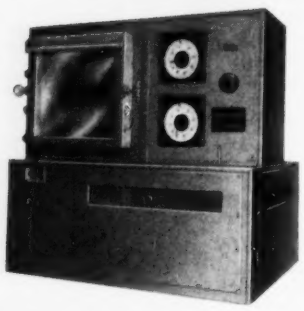
DC Amplifier: Will drive a one ma recorder, has gain of 200, and frequency range of zero to 100 kc.

*This statement refers to the fact that precision wirewound resistors are used for all attenuators and range resistances, and that the DC Amplifier is a highly degenerative system employing wirewound resistors for the beta network. It has been found that changes in gain with overload are in the order of .1 of 1% and are primarily due to the temperature coefficient of the resistors in the beta network.

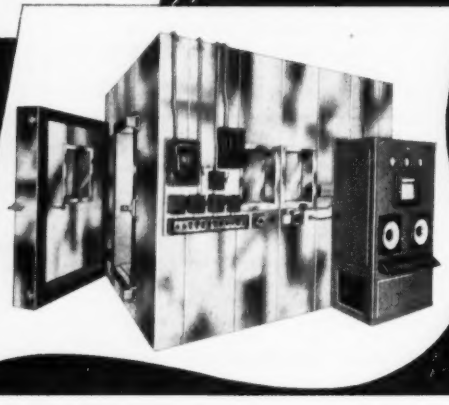
SOUTHWESTERN INDUSTRIAL ELECTRONICS COMPANY

For more information circle 81 on inquiry card.

Considering Environmental Test Equipment?



Be sure to look beyond the unit . . .



Bowser Technical Refrigeration pioneered the development and manufacture of environmental test equipment.

Bowser's complete engineering staff is available (at no obligation) to help in solving YOUR difficult test problems. Design engineers and production facilities are available to construct test equipment to meet your specialized requirements.

Typical of Bowser's standard test chambers are the Laboratory Unit and Walk-In Room shown above.

The Laboratory Unit has a temperature range from +200° F to −100° F, relative humidity range from 20% to 98%, altitude from sea level to 100,000 feet.

Standard Walk-In Rooms simultaneously produce altitude to 100,000 feet, temperature range from −100° F to +200° F, relative humidity from 20% to 98%.

Bowser also builds explosion chambers, sand and dust chambers, humidity simulation units, and environmental simulation chambers to meet any desired specifications.

Write for free descriptive bulletins or request a Bowser field engineer to consult on YOUR environmental test problem.

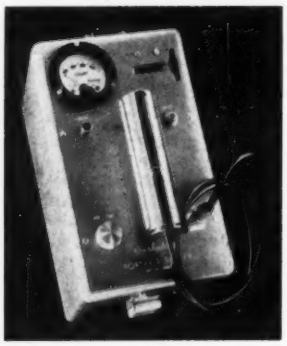
BTR

BOWSER TECHNICAL REFRIGERATION

DIVISION BOWSER INC TERRYVILLE CONNECTICUT

For more information circle **53** on inquiry card.

NEW INSTRUMENTS

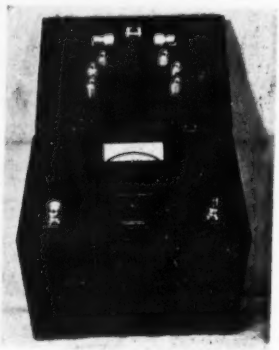


rate-meter survey instruments are useless because their statistical accuracy is limited. It contains an electronic scale-of-eight, a four-digit resettable register, and a meter for interpolation of binary count.—*Berkeley, Div., Beckman Instruments Inc., 2200 Wright Ave., Richmond, Calif.*

For more information circle **236** on inquiry card.

Radiological Electrometer

New "Farmer Radiological Electrometer" (English-made), for use by hospital radiologists and physicists for measuring x-ray and gamma radi-



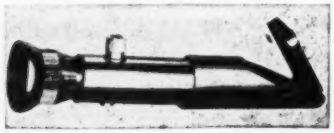
ation, can be used specifically for measuring tolerance dosages (from 0.5 to 54 r.), for controlling dosages in interstitial radium therapy, and for measuring x-ray dosages in body cavities; is practically independent of variation in battery voltage and in tube characteristics.—*The Atomic Center for Instruments & Equipment, Inc., 489 Fifth Ave., New York 17, N. Y.*

For more information circle **237** on inquiry card.

FOR THE LABORATORY

Serum-Protein Meter

New "Protometer" makes serum protein determinations in 5 seconds without use of reagents. Procedure is simple: place a drop or two of the

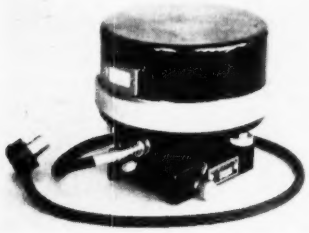


fluid on "Protometer" test plate, point instrument toward light source and read percent protein on a calibrated scale. Measuring range is 0-12 percent. Readings are corrected to 17.5 C. as standard. A temperature correction table supplied with instrument permits accurate readings at other temperatures.—*National Instrument Co., 5005 Queensbury Ave., Baltimore* 15, *Md.*

For more information circle **238** on inquiry card.

Back-reflection Camera

New back-reflection camera, for precise determination of atomic lattice constants in x-ray diffraction work,

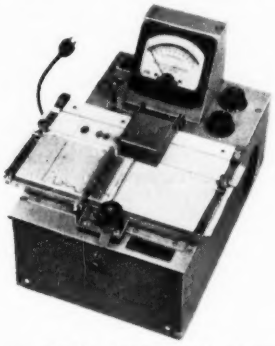


has a radius of 60 mm., weighs 9.5 lbs., covers a range of Bragg angle values from 59 deg. to 88.74 deg. V-notch reference marks eliminate film-shrinkage errors.—*Research & Control Instruments Div., North American Philips Co., Inc., 750 S. Fulton Ave., Mount Vernon, N. Y.*

For more information circle **239** on inquiry card.

Densitometer

New "Model 425 Densitometer for Partition Chromatography and Paper Electrophoresis" is said to make avail-



able "a simple instrument at modest price" in which the number of operating controls is minimized and in which taking readings on a large number of spots on long paper strips is made rapid and convenient. —*Photovolt Corp., 95 Madison Ave., New York 16, N. Y.*

For more information circle **240** on inquiry card.

Lead-glass Gown

New "Archer Gown," made of spun lead glass, protects vulnerable parts of human body from x-rays and beta radiation; is for radiologists, technicians and industrial inspection personnel who, heretofore, have had to depend entirely on lead rubber aprons

BOURNS

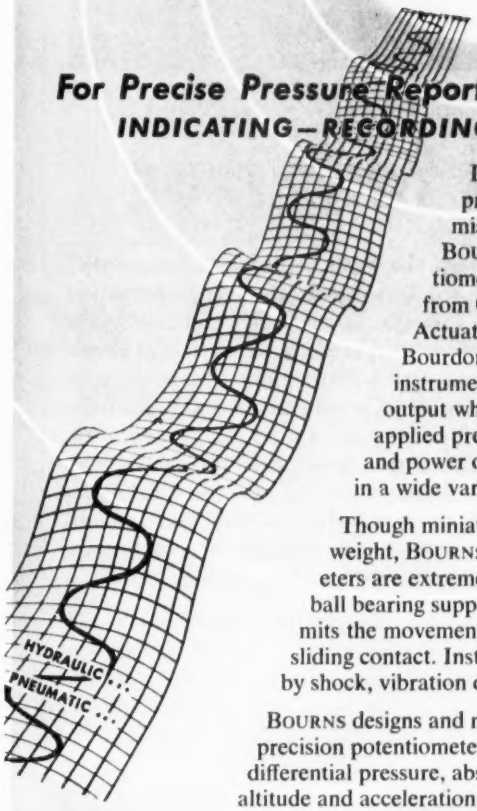
MINIATURE

GAGE PRESSURE

POTENTIOMETERS

For Precise Pressure Reporting...

INDICATING—RECORDING—CONTROL



Designed for measuring pressure in aircraft, guided missiles and other equipment, BOURNS Gage Pressure Potentiometers are available in ranges from 0-100 psi to 0-5,000 psi. Actuated by the flexure of a Bourdon tube, these precision instruments have an electrical output which is linear with the applied pressure. Resolution of 0.4% and power of ½ watt are obtainable in a wide variety of resistances.

Though miniature in size and light in weight, BOURNS Gage Pressure Potentiometers are extremely rugged and accurate. A ball bearing supported linkage system transmits the movement of the Bourdon tube to the sliding contact. Instruments are not damaged by shock, vibration or nominal over-pressure.

BOURNS designs and manufactures other precision potentiometers for measuring position, differential pressure, absolute pressure, altitude and acceleration.

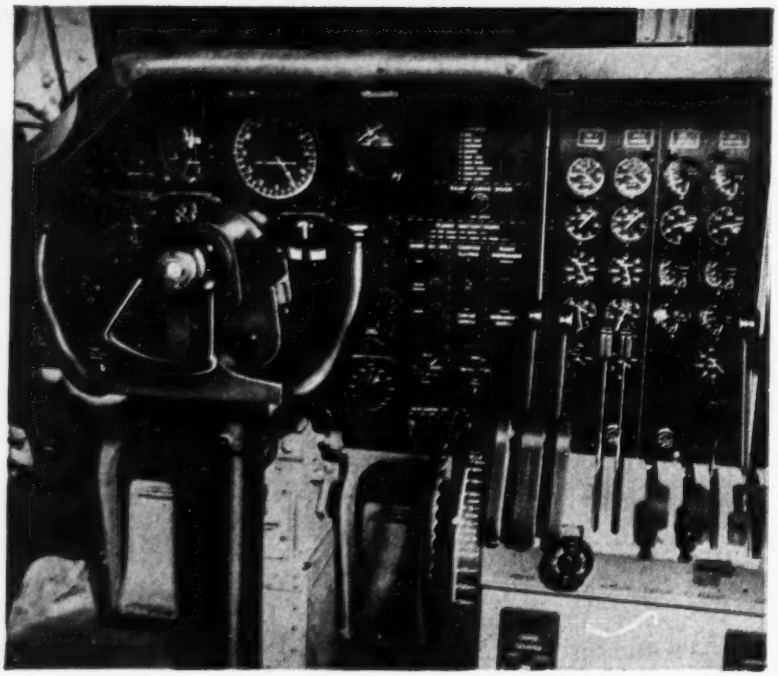
BOURNS is also the creator and exclusive manufacturer of the TRIMPOT.

BOURNS LABORATORIES

6135 Magnolia Avenue, Riverside, California

Technical Bulletin on request, Dept. 23.

For more information circle **54** on inquiry card.



One false reading and disaster may strike. Here there's . . .

no room for error

According to an Air Force survey, the most common "pilot-errors" are: misreading the instrument pointers, reversals in interpretation of readings, inability to see the instrument properly, and mistaking one instrument for another. A poorly lighted panel, or a dial that's difficult to read, and the finest scientific instrument can be as misleading as a dime-store watch. In short, where accuracy is essential you need MORE than precision. You need see-ability, and *readability*.

That's the advantage of U. S. Radium edge-lighted panels. Besides being the best looking panels available, they are also the most functional. Their clean, modern lines are a reflection of the "human engineering" in their design. They are lighted scientifically and *uniformly*. For accurate, at-a-glance readings they have few, if any equals.

Whatever your requirements — for dials, edge-lighted panels, or nameplates — whether luminous or non-luminous — and in whatever materials or finishes you desire — you name it, we make it. Get the finest — U. S. Radium. Write or phone for complete information. Dept. I-10, U. S. Radium Corp., 535 Pearl Street, New York 7, N. Y.

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MAKERS OF: Luminescent Materials: Radioactive, fluorescent, phosphorescent • Powders: Cathode-ray tube, television tube • Radium Locators: Pendants, lenses, buttons, screws, markers • Static Eliminators • Radioactive Foils — Alpha-Ray Ionization Sources • X-Ray Screens • Processed Isotopes • Neutron Sources • Radiation Sources and Standards.

SEE OUR CATALOG IN SWEET'S

For more information circle **55** on inquiry card.

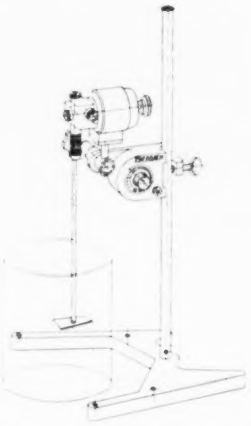
NEW INSTRUMENTS

and risk exposure of arms, shoulders and lower legs to scattered radiation. It is effective in light weights; is flexible and strong; chemically resistant, non-deteriorating in storage; non-shrinking, non-allergic and fireproof. —*Bar-Ray Products, Inc., 209-25th St., Brooklyn 32, N. Y.*

For more information circle **241** on inquiry card.

Laboratory Stirrer

New "Universal" stirrer can be employed in many positions because of its double swivel clamp with easy-operating hand-wheel lock. Speeds up

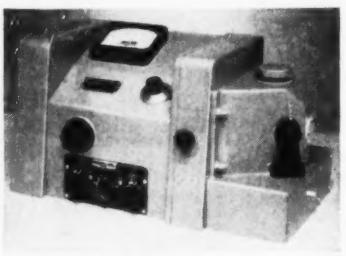


to 5000 rpm.; 1/50th hp.; maximum torque at various speeds by employing two output shafts, one driven through a gear reducer. Ventilated rheostat housing also serves as clamp to mount on special support.—*Eberbach Corporation, Ann Arbor, Michigan.*

For more information circle **242** on inquiry card.

Comparison Colorimeter

New "Model C Color-Eye," completely redesigned for greater versatility and lower cost, replaces earlier models of this instrument for industrial color measurement and comparison; computes logarithmically to simulate response of eye and brain. Tristimulus type filters permit measurement under daylight or artificial sources. Standard instrument furnished with either diffuse (sphere-type) or 45-deg. normal illumination and viewing, with illuminators interchangeable if desired. Up to 15 filter combinations can be installed in one instrument including narrow-band interference-type for abridged spectro-



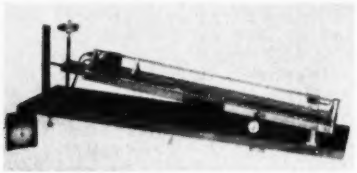
photometry. Transmission and reflectance samples can be accommodated and surface gloss included or excluded. Available new features include forced cooling, direct reading in terms of *X*, *Y*, and *Z* adjusted values, dual area viewing for large and small sample areas, improved type commutator system, and optical location means for small areas. Equipment is designed for production control use by semi-skilled personnel.—*Instrument Development Laboratories, 163 Highland Ave., Needham, Mass.*

For more information circle **243** on inquiry card.

TESTING

Surface Coating Analyzer

New surface-coating evaluating apparatus has drying time meter which measures viscosity of air-drying films at gel point corresponding to "set to

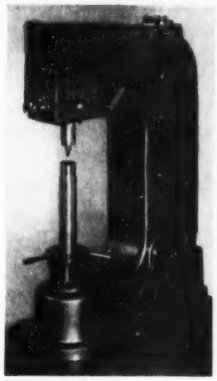


touch," and thereafter the progressively decreasing tack, and increasing rigidity and hardness of gel to end point of final cure. Principle involved is automatic recording of times of descent of a rolling ball on 1-meter segments of films as angle of inclination of aluminum channel support for the glass plates is reduced from 10 to 0.1 deg. of arc. Instrumental facilities are provided for applying two parallel film drawdowns of desired thickness, a portable electromechanical timer for measuring ball transit times, a dial indicator for securing predetermined reference times on uncoated glass plates at different angle settings, and an elapsed time meter. —*H. R. Moore Co., 200 W. Montgomery., Hatboro, Pa.*

For more information circle **244** on inquiry card.

Hardness Testers

New "Galileo Superficial Hardness Tester," providing loads starting at 5 kgm., and "Galileo Standard Hardness Tester" which handles Rockwell measurements from 30 to 1000 Brinnel units, Brinnel tests, special loads and Vickers measurements, are made in Italy; are said to be "the first hand-operated metal hardness testers to provide automatic load changing and magnified optical readings at no extra cost; accept samples up to 7.5 in. thick; are supplied with a variety of anvils and steel ball penetrators (diamond cone penetrator and complete line of other accessories available). Service available in New York and Chicago.—*Opplem Co., Inc., 352 Fourth Ave., New York 10, N. Y.*



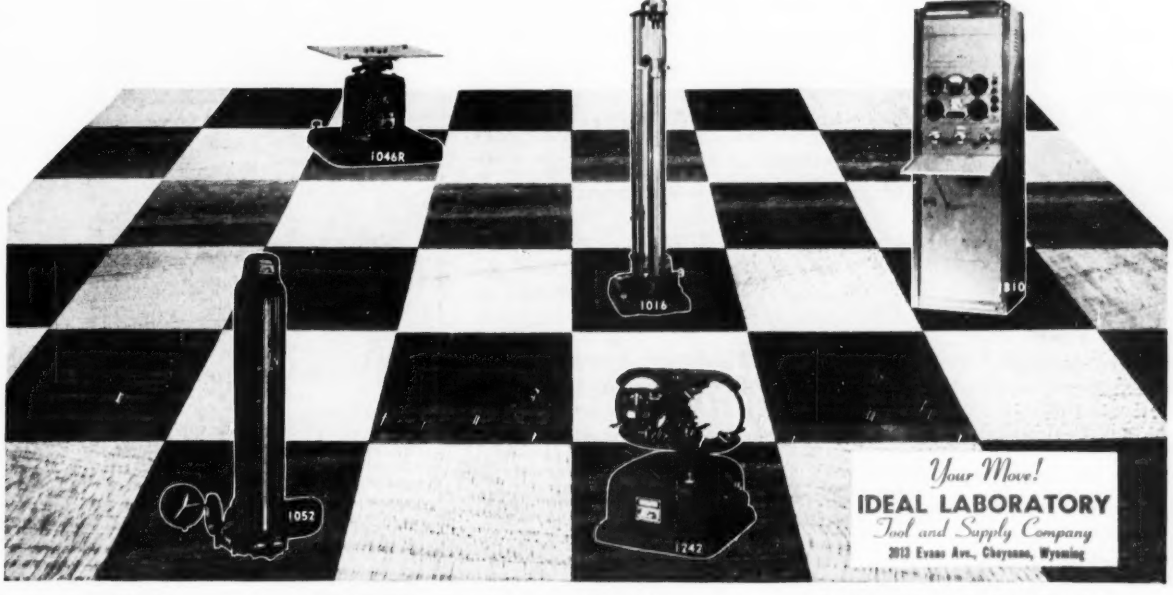
For more information circle **245** on inquiry card.

Corona Test Sets

New corona test sets for non-destructive evaluation of electrical insulation consist of a control unit, a detector unit, and a high-voltage corona-free testing transformer which incorporates means for picking up

PRECISION INSTRUMENTS

like these—**HELP YOU STAY A JUMP AHEAD!**



Model 1052 Automatic Indicating Barometer

Model 1046R Testing Table for All Gyro Aircraft Instruments

Model 1016 Barometer for Altimeter Calibrating

Model 1242 4-Speed Turn and Bank Tester

Model 1810 Tachometer Test Stand

For more information circle **56** on inquiry card.

We at ASCO manufacture a wide range of both Mechanically and Magnetically Held Relays. Accordingly, we can *impartially* recommend the best relay for your application.

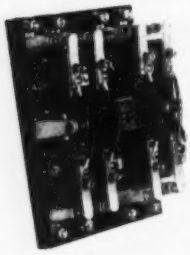
We Recommend a Mechanically Held Relay:

1. If the relay must "stay put" on loss of line voltage, or under low voltage conditions.
2. If AC hum cannot be tolerated.
3. If coil loss is undesirable.

Mechanically Held Relays Can Be Used:

1. As primary relay devices to control Contactors, Solenoid Valves, and similar equipment.
2. As branch circuit devices to control instrument processes.
3. For Automatic Control Systems to (a) maintain circuit control regardless of momentary interruptions in control line caused by low voltage conditions, or by associated relays; or (b) provide "memory circuits" and to permit preset control operations.

You'll want to use ASCO compactly constructed Mechanically Held Relays because they are locked in either position by sturdy linkages — no delicate hooks or latches to be damaged. Relays are operated by a single coil mechanism — positive in each direction.



AVAILABILITY:

10 AMPERES — Up to 12 poles normally open, and 12 poles normally closed.

25 AMPERES — Up to 6 poles normally open, and 6 poles normally closed.

OTHER RELAYS include control, power, voltage-frequency sensitive, latching, time delay, close differential, reverse current, special purpose, etc.

Many Instrument Manufacturers take their Solenoid Valve and Electromagnetic Control problems to the widely experienced ASCO Engineering Staff. For, in dealing with ASCO, the Instrumentation Engineer can purchase both Solenoid Valves and Electromagnetic Control Panels from *one reliable source*.

May we send you complete information on our line of Mechanically Held Relays — also the Magnetically Held Designs?

ASCO Electro-Magnetic CONTROLS

Automatic Switch Co.

385-T Lakeside Avenue, Orange, N. J.

For more information circle **57** on inquiry card.

NEW INSTRUMENTS

corona signals from the equipment under test. "Model 1" (illustrated) is rated 0.75 kva., 20 kv. continuously or 1.5 kva. for intermittent duty; also available with a larger control unit with a rating of 2 kva. continuous and 5 kva. intermittent-duty. "Model 2" is rated up to 10 kva., 35 kv. continuously or 20 kv. intermittent duty.—*James G. Biddle Co.*, 1316 *Arch St., Philadelphia 7, Pa.*

For more information circle **246** on inquiry card.

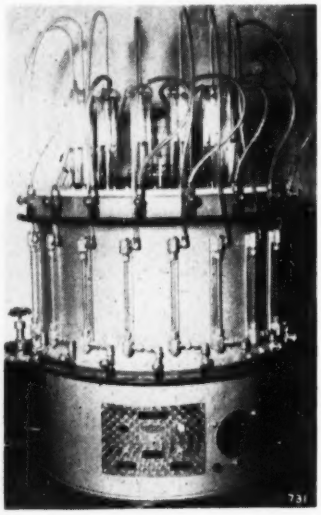
Sequence-timer Tester

New electrical testing device, capable of predetermining accuracy of sequence control units, comprises two separate assemblies: (1) Pre-test Fixture tests motor windings and simultaneously positions control cams prior to actual sequence test. After control cams have been positioned, timer mechanism is placed in (2) Test Stand, where separate compartments for 16 individual timing units are provided and all electrical contacts are established automatically. Timers are tested automatically throughout their entire sequence cycle. Should any timer not follow correct pattern, a "reject" light goes on and timer stops at defective phase.—*Encore Mfg. Corp.*, 4338 *Carnegie Ave., Cleveland 3, Ohio.*

For more information circle **247** on inquiry card.

Oil Oxidation Tester

New "Oil Oxidation Test Apparatus" determines oxidation and sludging resistance and service life of automotive, aircraft, steam-turbine, and

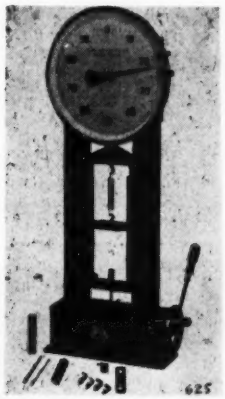


transformer oils; may be used to study oxidation characteristics of any organic liquid under constant temperature and constant air or oxygen contact; meets all requirements of six American and British standard tests; may be used in any other oxidation test requiring contact between an oil (kept at constant temperature) and a precisely-metered volume of air or oxygen.—*Technical Equipment Co.*, 743 *Dwight Way, Berkeley 10, Calif.*

For more information circle **248** on inquiry card.

Spring Tester

New 100-lb.-capacity spring tester has 15-in. diam. dial; meets National Bureau of Standards requirements for

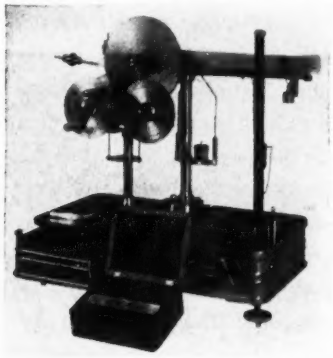


accuracy of 0.25 percent; is adaptable for quantity production testing at rate of 400 to 600 tests per hour. Spring diameters up to 4 in. and lengths up to 12 in.—*The Carlson Co., 277 Broadway, New York 7, N. Y.*

For more information circle **249** on inquiry card.

Torsion Spring Tester

New "Model 735-S" torsion spring tester is for spiral and torsion springs to 1 in. long and 2 in. OD, capacity up to 2000 g-cm. in increments of 0.1 g-cm. Deflection is applied by handwheel, is read to ½ degree. Spring



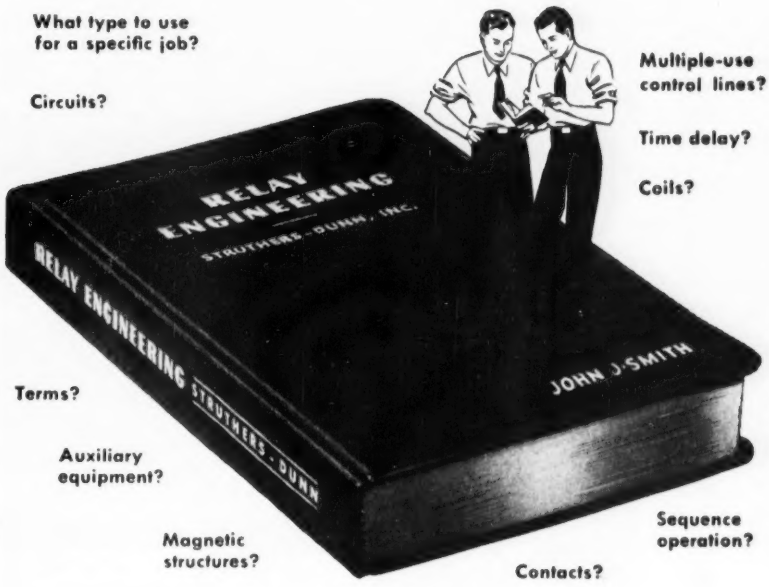
under test is in full view at all times. Calibrated chain post makes for quick, accurate reading of small loads. Tester has a magnetic damper for fast reading, and is so designed that its calibration can easily be checked by using standard weights. Also available are sets of gram weights and ounce weights, boxed to fit drawer in base of tester.—*John Chatillon & Sons, 85 Cliff St., New York 38, N. Y.*

For more information circle **250** on inquiry card.

Metal Tester and Sorter

New "FM-100 Magnatest Conductivity Meter" gives conductivity measurements of non-ferrous conducting materials directly: operator places hand probe on a part and reads dial. In some cases, readings can be used to sort mixed lots of metals and alloys. Indent hardness test can, in many cases, be replaced by nondestructive

What's your relay or timer question?



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For more information circle **58** on inquiry card.

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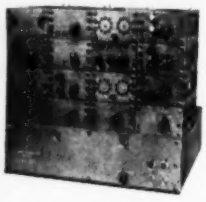

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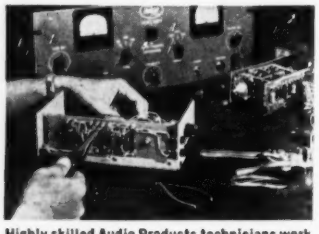

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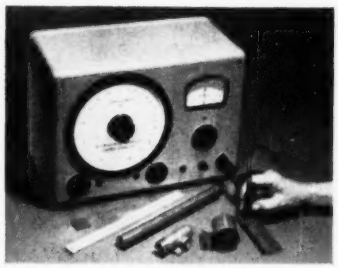
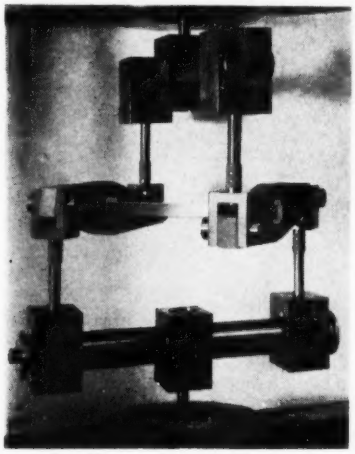


"FM-100," which can also be used for process and quality control in heat treatment, and controlling purity of melt of non-ferrous metals and alloys. —*Magnaflux Corp.*, 7300 *W. Lawrence Ave., Chicago* 31, *Ill.*

For more information circle **251** on inquiry card.

Torsion Test Device

New "Schaevitz Torsion Device" produces pure torsion on a tension testing machine; twists specimens up to ¾ in. square and from 2 to 12

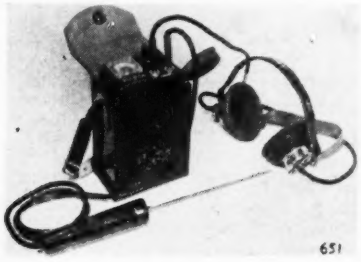


in. long (plus 2 in. engaged by torque bars) to a maximum angle of 24 deg. Maximum torque load is 60,000 in.-lb., obtained by applying a 12,000-lb. tension load.—*Baldwin-Lima-Hamilton Corp., Philadelphia* 42, *Pa.*

For more information circle **252** on inquiry card.

Audio-video Detector for Mechanism Noises

New "Model V" is an audio-video model of "Elec-Detec," portable instrument for locating noise sources in mechanical equipment; includes a milliammeter for checking sound impulses visually, in addition to standard headphones. Operator can "see as well as hear" location of source of trouble in bearings, gears, cams, etc. —*Anco Instrument Div., American Name Plate & Mfg. Co.*, 4254 *W. Arthington St., Chicago* 24, *Ill.*

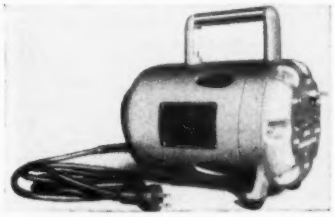


651

For more information circle **253** on inquiry card.

Tachometer Tester

New "Model 1100 Tachometer Tester" has seven output speed shafts of 300 to 1800 rpm. for testing portable tachometers. Reversing switch permits

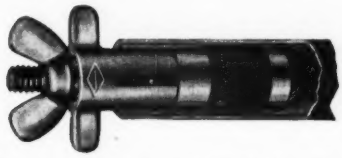


clockwise or counter-clockwise rotation. Tester is as accurate as an electric clock (operates on 115 v.ac.); weighs 23 lbs.—*B. K. Sweeney Mfg. Co.*, 1601 — 23*rd St., Denver* 17, *Colo.*

For more information circle **254** on inquiry card.

Tubing Test Plugs

New test plugs make it possible to test tubing installations before they are put into service or when trouble-

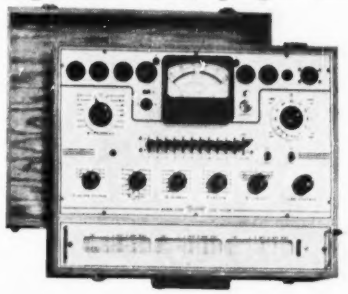


shooting for leaks. Plug is inserted and wing-nut is tightened, expanding synthetic rubber portion of plug. Pressures up to 100 psi.; all lines except where fluid would deteriorate synthetic rubber; five sizes: 0.25, 0.375, 0.50, 0.625 and 0.75 in. OD.—*The Imperial Brass Mfg. Co.*, 1200 *W. Harrison St., Chicago* 7, *Ill.*

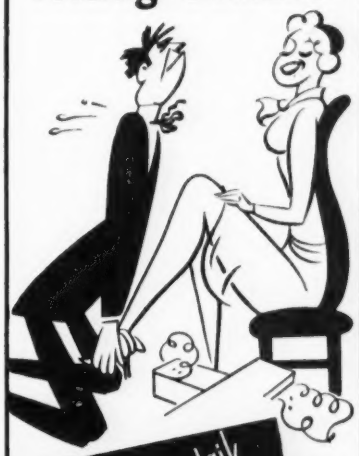
For more information circle **255** on inquiry card.

Tube Tester

New "Model 3423 Proportional Mutual Conductance Tube Tester" handles perplexing tube testing problems in radio servicing, industry, labs, etc., by applying a high-frequency signal to grid and measuring signal com-



Fitting Solution



Only Koncentrik

STAINLESS STEEL FITTINGS

STOP COSTLY DANGEROUS LEAKS

WITH Teflon DOUBLE SEALING ACTION

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"Over 1200 tube fittings in Stainless or Monel"

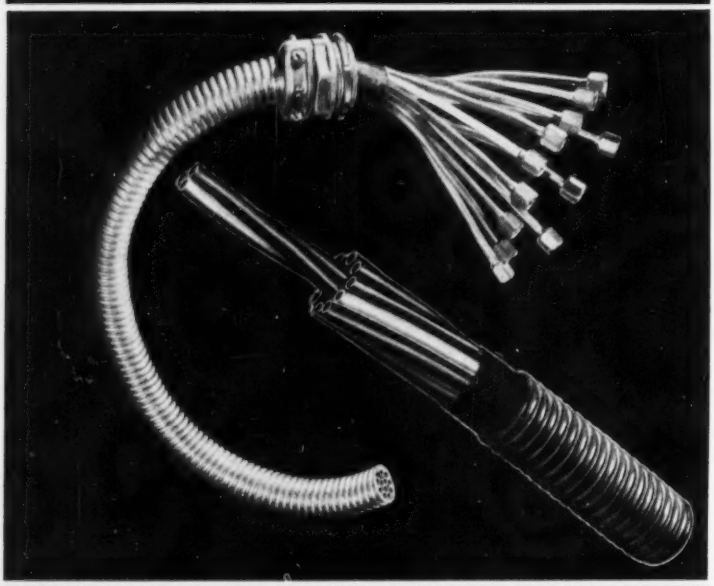
You'll want to complete your data file with this handy, dual purpose catalog. Covers both parts specifications and technical information on Koncentrik flared-tube fittings . . . the only line that gives you DOUBLE protection against dangerous leaks with the patented, Teflon-reinforced seat. Over 1200 combinations listed, for tubing through 1" O.D. Literature also available covering Powell valves with machined-in Koncentrik connections. Write today.

THE SPECIAL SCREW PRODUCTS CO.

5445 Dunham Rd., Bedford, Ohio

For more information circle **60** on inquiry card.

CRESCENT



ARMORED MULTITUBE

For use with instruments and process control equipment

Here is a new way to make substantial savings on moderate to long runs on 1/4", 5/16", 3/8" and 1/2" O. D. tubes.

CRESCENT ARMORED MULTITUBE is an armored group of long length tubes twisted together to permit bending without any distortion of the tubes, which are thoroughly protected from injury during and after installation by a flexible, interlocked, galvanized steel armor.

One tube in each layer has a bright blue color, which permits a ready identification of each tube at both ends. This is a real time-saving feature as the installers can connect both ends without the necessity for tracing through each tube. The position of each tube in each layer, with respect to the color-coated tube in that layer, remains the same throughout any length of ARMORED MULTITUBE.

Long, continuous lengths up to 1,000 ft. save waste and short ends. Tubes are available in copper, aluminum, polyethylene and other plastics.

SEND FOR BULLETIN GIVING COMPLETE INFORMATION AND ENGINEERING DATA

CRESCENT
INSULATED WIRE & CABLE CO.
TRENTON 5, N. J.

For more information circle **61** on inquiry card.

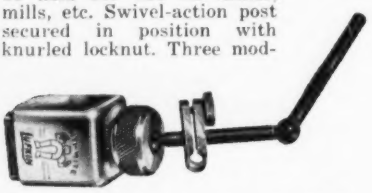
ponent in output by a special instrument circuit, closely simulating operating conditions. In plate circuit, a high-Q tuned circuit which responds only to 4 kc. is used to extract amplified signal. Thus, hum and ripple, and tubes with open grids, cannot give false readings. Flexible switching ties in with speedy roll chart.—*The Triplett Electrical Instrument Co., Bluffton, Ohio.*

For more information circle **256** on inquiry card.

FOR THE SHOP

Magnetic-base Holders

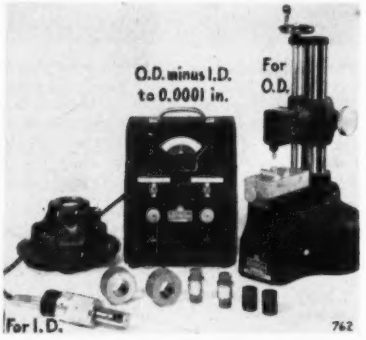
New "Miti-Mite" magnetic-base indicator holders eliminate cumbersome haphazard clamping. With attachments, nearly all dial indicators can be held for use on lathes, mills, etc. Swivel-action post secured in position with knurled locknut. Three models available: "No. 100" with 50-lb. pull permanent magnet and attachments; "No. 101": same but with extra-fine adjustment feature; "No. 150": heavy-duty, with 100-lb. pull permanent magnet.—*Lufkin Rule Co., Saginaw, Mich.*



For more information circle **257** on inquiry card.

Actual-clearance Indicator

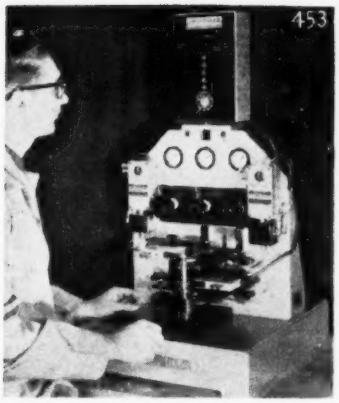
New "Radial Internal Clearance Comparator," for minimizing trial-and-error in selective-assembly programs, indicates actual clearance between two parts (say a piston and a cylinder) which are to mate. It comprises two "Electrolimit" gages, a "DOU Meter," and max. & min. masters.—*Pratt & Whitney Div., Niles-Bement-Pond Co., West Hartford 1, Conn.*



For more information circle **258** on inquiry card.

Quintuple Gage

New "Multicheck" inspects simultaneously five bearing diameters and indicates by means of lights whether or not dimensions are within tolerance,

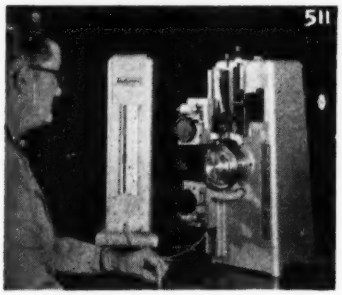


oversize or undersize; is equipped with three "Airlectric" gage heads and two "Electrichek" gage heads. Shafts can be inspected at rate of 600 to 800 per hour.—*The Sheffield Corp., Dayton* 1, *Ohio.*

For more information circle **259** on inquiry card.

Radial-play Gage

New type of radial play gage uses "Plunjet" gaging cartridge and a column-type air gage for measuring ra-

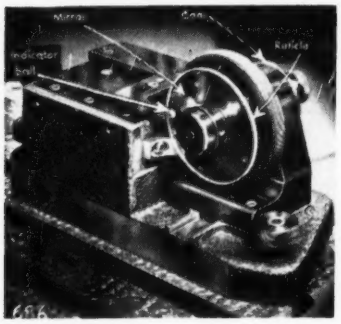


dial play in ball and roller bearings. Two standard models: one for bearings with OD from 18 to 90mm.; the other for OD from 90 to 180mm. Measuring loads adjustable to standards of AFBMA.—*The Sheffield Corp., Dayton* 1, *Ohio.*

For more information circle **260** on inquiry card.

Optical Gaging System for Cam Contours, etc.

New "Staging Fixture" for installation on Kodak Contour Projector permits inspection of entire contour of irregular cams, etc. Method may be likened to a "bouncing ball" method



STEP AHEAD TO EXTENDED ANALYTICAL RANGE

WITH AUGMENTED BASIC X-RAY DIFFRACTION

★ The NORELCO line of X-ray analytical equipment is designed with integrating components, each of which can be added progressively to the basic X-ray Diffraction Unit—providing maximum utility ranging from film techniques, through automatic recording diffractometry, to rapid X-ray spectrographic analyses. This feature of progressive growth is engineered into NORELCO X-ray analytical equipment to enable laboratories with limited financial resources to utilize the outstanding facilities offered by this vital analytical science. With simple modifications, the automatic recording provided by the Diffractometer or the quantitative identification of elements may be accomplished with the X-ray Spectrograph. An *outstanding* NORELCO feature.

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For more information circle **62** on inquiry card.

precision electronic instruments by DeJUR

1½" SQUARE
WATERTIGHT
Panel Meter

ACTUAL SIZE

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- Available with 2 terminal designs
  1. Solder terminal
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- Multi-color or luminescent scales and pointers
- Proven external pivot D'Arsonval movement
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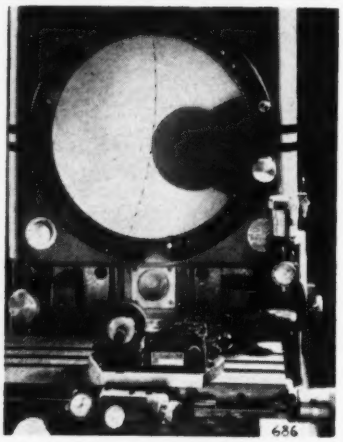
For more information circle **63** on inquiry card.

NEW INSTRUMENTS

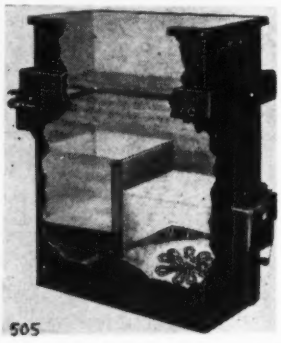


of indication: cam is mounted on an arbor which may be turned by hand. Turning cam actuates a follower which carries with it an indicator ball. How closely indicator ball follows tolerance lines (also rotating with cam) may be readily watched on projector screen at high magnification.—*Optical Gaging Products Inc., 26 Forbes St., Rochester 11, N. Y.*

For more information circle **261** on inquiry card.

Degreaser

New "No. 100 CS" combination vapor degreasing unit handles 200 lbs. of work per hour either in baskets or



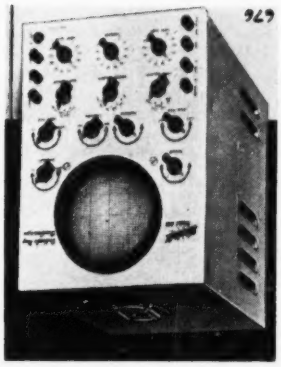
as individual pieces. It incorporates cool rinse, hot rinse and vapor degreasing because it has both a rinse and boiling sump along with a water-jacketed vapor area. Distilled solvent is collected by a condensate return trough, passed through a water separator and returned to rinse sump. Boiling sump is fed by overflow from rinse sump.—*Phillips Mfg. Co., 3415 W. Touhy Avenue, Chicago 45, Ill.*

For more information circle **262** on inquiry card.

ELECTRICAL INSTRUMENTS

Five-inch TV CRO

New "Model 665" 5-in. television cathode-ray oscilloscope has all features needed by TV technicians, also for smaller laboratories and as a field



servicing 'scope. Frequency range from 0.5 cps. to 700 kc., down 3 db; no drift; less than 1 percent tilt; less than 2 percent overshoot; accelerating potential 1775 volts; power consumption 35 watts.—*The Hickok Electrical Instrument Co.*, 10514 *Dupont Ave., Cleveland* 8, *Ohio.*

For more information circle **263** on inquiry card.

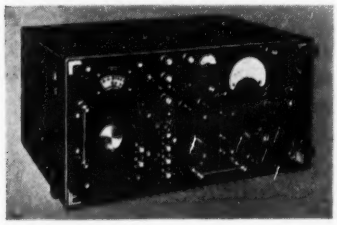
VTVM

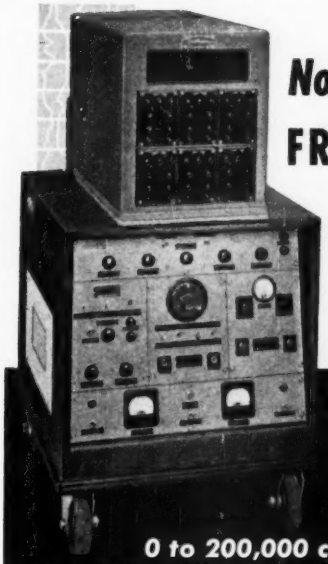
New "Model 1040" a-c. five-range vacuum-tube voltmeter can be used at audio and supersonic frequencies; is recommended for (1) vibration studies involving low frequencies, (2) frequency characteristics and gain measurements on amplifiers, (3) transmission losses on telephone circuits: filter and carrier systems up to 25,000 cps., and (4) acoustic measurements such as determination of frequency response of microphones and loudspeakers. Because of its high sensitivity, it can be advantageously used as a null detector in a-c. bridge measurements. Among features: independence of line voltage variations and changes in tube characteristics; logarithmic voltage scale calibrated from 1 to 10, plus a linear decibel scale calibrated from 0 to 20 db.—*Freed Transformer Co.*, 1718 *Weirfield St., Brooklyn (Ridgewood)* 27, *N. Y.*

For more information circle **264** on inquiry card.

Noise and Field Meter

New "Model NF-105", commercial equivalent of AN/URM-7, is intended for noise and field intensity measurements, also serves as a sensitive VTVM, and a standard impulse noise source. Frequency range 20 to 1000 Mc. by means of three plug-in heads, containing r-f. and corresponding i-f. circuits. All tuning ranges are

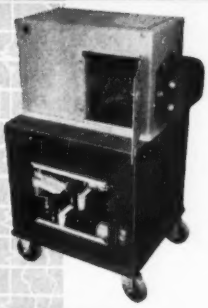




No more worries about
FREQUENCY RESPONSE
or
WRITING SPEED.

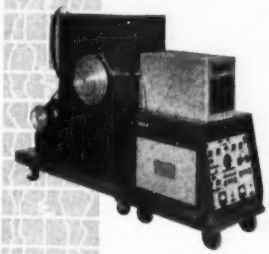
The NEW and PHENOMENAL

HATHAWAY Type SC-16
OSCILLOGRAPH
with 6 elements is *flat from*
***0 to 200,000 cycles per second*, and its traces**
have a writing speed of *5 million inches per second.*



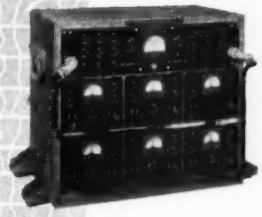
Fast transients and high-frequency phenomena now can be accurately recorded.

Several types of continuous-drive record magazines are available for 6-inch sensitized paper and film, and for 35-mm film. The magazine shown on the oscillograph at the left accommodates 100-foot rolls of record paper.



Drum-type magazines, both small and large, are valuable for short high-speed records. The large drum-type magazine at the left has a drum 3 feet in diameter and 6-inches wide. It can be driven at 3000 RPM for a *chart speed of 6000 inches per second* when high resolution is needed. It can be used to take one 10-foot record or a larger number of shorter records.

The ASC-10 6-element direct-coupled amplifier will drive the SC-16 oscillograph from potentials of millivolt level.



Useful for strain recording to 100 Kilocycles.

AUTOMATIC OPERATION Initiate a transient with the oscillograph, or let the transient start the oscillograph.

QUICK-CHANGE TRANSMISSION for wide range of record speeds.

PRECISION TIME LINES.

Z-AXIS MODULATION for timing to one-tenth millisecond.

QUICKLY-INTERCHANGEABLE LENS STAGES for different record and trace widths.

Write for Bulletin 2G1-L for details.

Write for FREE copy of Hathaway Engineering News

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For more information circle **64** on inquiry card.

TUBELESS MAGNETIC AMPLIFIER DC SUPPLIES

for Automotive and Aircraft Industries

Sorensen Nobatrons Model MA6/15 and Model MA2850 are tubeless — using magnetic amplifier principles. They have plenty of current capacity — 100 amps at 6 volts or 75 amps at 12 volts in the MA6/15 and 50 amps at 28 volts in the MA2850. Please see the specs below.

The MA6/15 is designed primarily as an automotive production test instrument for use in checking window motors, heaters, clocks, radios, headlight dimmers, ignition systems, air conditioners, cigarette lighters. The MA2850 can be used for testing aircraft heaters, pitch changers, inverters, radar, fire control systems, etc. Built around tubeless circuits, both models are carefully engineered and built to give you years of trouble-free, dependable service. Write for information now!

SPECIFICATIONS

Model MA2850

Input voltage range	190-230, 3Ø, 4 wire, 60~
Output	28 volts DC, adjustable between 23 and 36 volts.
Current	0 - 50 amperes
Ripple	3% max RMS
Regulation accuracy	±1% against line and load combined
Time constant	0.5 seconds under worst conditions
Dimensions	15½" wide x 25⅜" high x 13" deep

Meters are standard. Units are self contained.

Model MA6/15

Input voltage range	210-250 VAC, 1Ø, 60~
Output	Adjustable 6 - 7.7 volts DC from 0-100 amperes Adjustable 12 - 15.4 volts DC from 0 - 75 amperes
Ripple	1% max RMS
Regulation accuracy	±1% against line and load combined
Time constant	0.2 seconds under worst conditions
Dimensions	21" wide x 36" high x 15" deep

Meters are standard. Cabinets optional.

SORENSEN

SORENSEN AND COMPANY • 375 Fairfield Ave., Stamford 2, Conn.

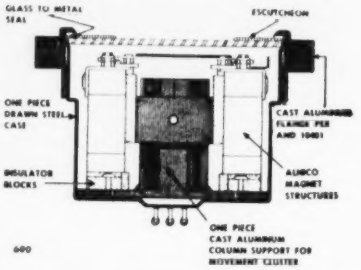
For more information circle **65** on inquiry card.

equipped with tuned circuits preceding first r-f. amplifier, thus minimizing possibility of pulse overload and cross modulation.—*Empire Devices Products Corp., 38-15 Bell Blvd., Bayside 61, N. Y.*

For more information circle **265** on inquiry card.

Aircraft Multi-element Electrical Instruments

New series of improved 2-, 3-, and 4-element aircraft instruments comprises glass-to-metal hermetically-sealed types which incorporate mak-



er's p-m. m-c. movements and new columnar construction which provides rigidity and precise alignment of elements.—*Marion Electrical Instrument Co., Manchester, N. H.*

For more information circle **266** on inquiry card.

UHF Sweep Generator

New "Model 130 UHF Sweep Generator" features single range tuning and 0 to 30 Mc. sweep width; is designed for laboratory, production test or service department. Other features include: At least 1-volt output into 75 ohms; continuously-variable attenuator; blanked signal on return sweep providing reference base line; no beating; no multiplication.

A low-cost balun is available for conversion to 300 ohm load.—*New London Instrument Co., P. O. Box 189, New London, Conn.*

For more information circle **267** on inquiry card.

CRO Voltage Calibrator

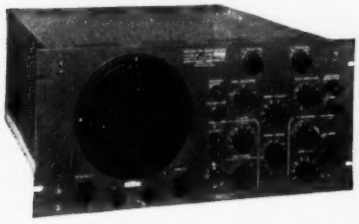
New "Model 495 Oscilloscope Voltage Calibrator" provides peak-to-peak voltage measurement of complex TV waveforms, may also be used to calibrate vertical, horizontal, and intensity (Z) axis of any 'scope, or as a calibrated voltage source for stage-by-stage measurement of gain, adjustment of bias on limiter stages, and measurement of amplitude required to modulate or trigger. Square-wave output at power-line frequency with full scale readings of 0.1, 1, 10, or 100 volts peak-to-peak; amplitude variable from zero on each range. Accuracy of output dial reading 5 percent of full scale

on each range; decade attenuator composed of 1-percent resistors; regulated power supply compensates for line voltage variation. Available in kit and wired form.—*Electronic Instrument Co., Inc., 84 Withers St., Brooklyn 11, N. Y.*

For more information circle **268** on inquiry card.

Rack-mounted Oscilloscope

New "Type 304-AR" is rack-mounted electrical equivalent of "Type 304-A" cathode-ray oscilloscope; fea-

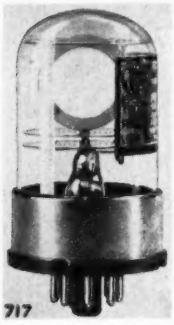


tures screen specially calibrated for reading any portion of signal directly in volts.—*Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.*

For more information circle **269** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

Stabilized Crystal

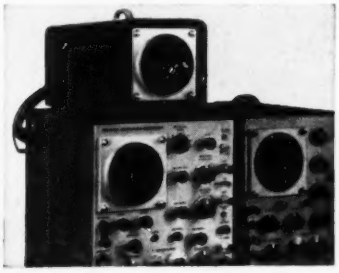


New "JK G-12" stabilized crystal, specially designed for "difficult" 500-1500-kc. range, is said to provide ultra-stable frequency control for applications such as frequency standards, timing and counting circuits, and broadcast equipment.—*James Knights Co., Sandwich, Ill.*

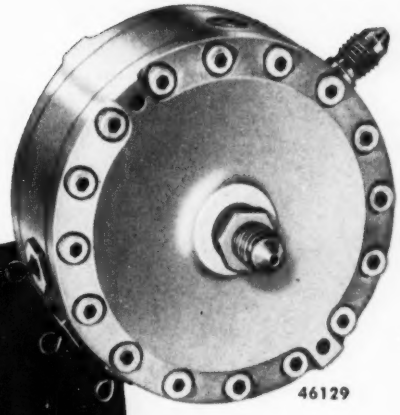
For more information circle **270** on inquiry card.

Dual-Beam CRO Converter

New "Model 3CT1" wide-band dual-beam conversion unit for use with two "Tektronix" oscilloscopes, is usable with "Tektronix Models 511, 512 and 514" without any loss in 'scope operating features: 'scopes can be used either individually or with converter



transmission of pressure information



Giannini pressure transmitters

RESISTANCE TYPE

GAGE • ABSOLUTE • DIFFERENTIAL

ACCURATE
SMALL SIZE
RUGGED
LIGHTWEIGHT

High Pressure Transmitters

Giannini pressure transmitters accurately translate pressure into proportional electrical signals of relatively high power – signals, that require little or no amplification for utilization. These high pressure transmitters incorporate a unique, direct-coupling arrangement between bourdon tube and potentiometer element which obtains movement amplification without the use of gearing or linkage, thus giving high sensitivity, repeatability, and low hysteresis. Specific models are available for operation under either normal or extreme conditions of vibration and acceleration.

Models also available for low pressure and high altitude applications.

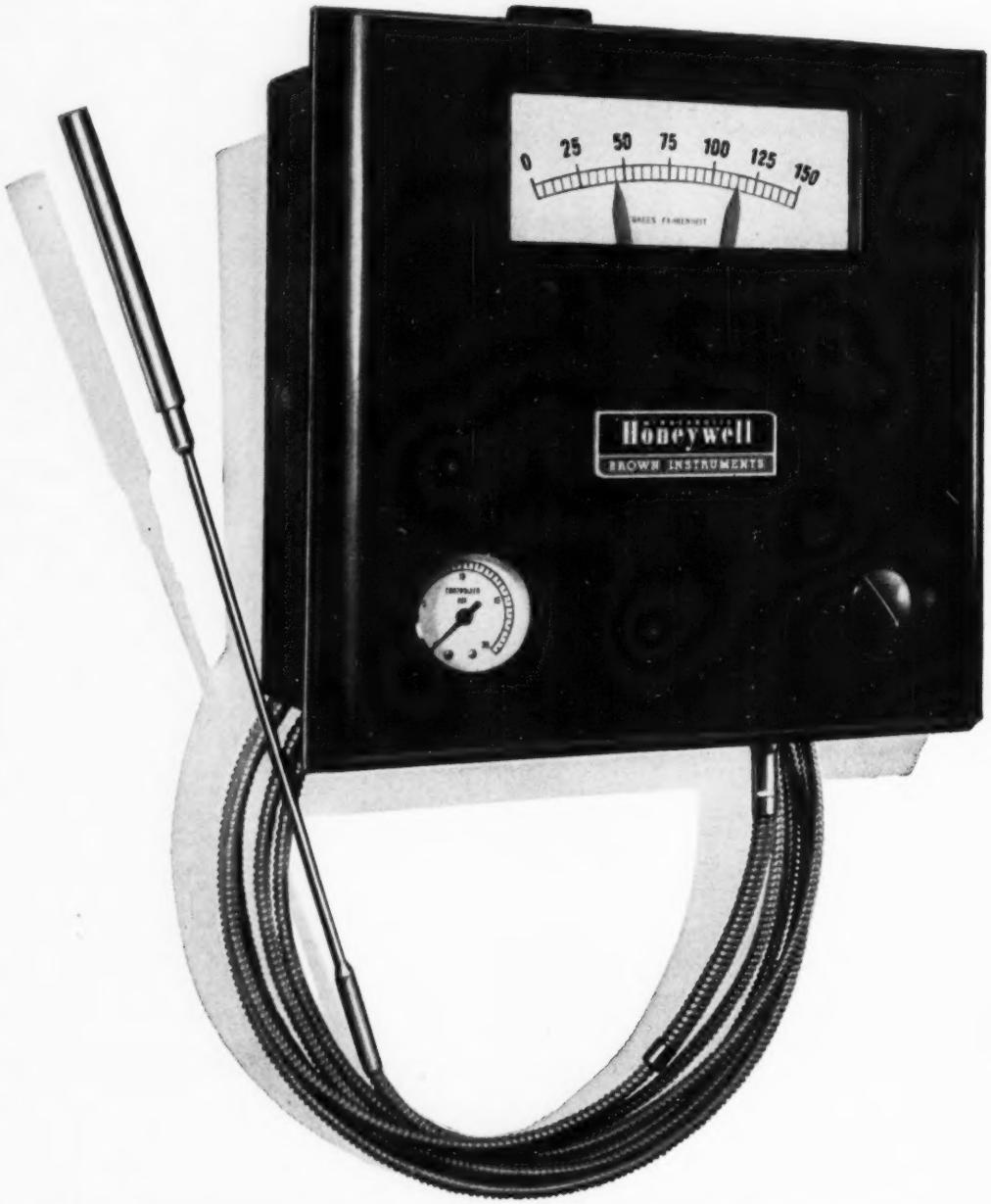
MODEL	WEIGHT	GAGE	ABSOLUTE	DIFFERENTIAL
* 46129	0.75 lbs.	0-100 psig up to 0-600 psig	15-100 psia up to 15-600 psia	0-100 psid up to 0-600 psid
46118	0.3 lbs.	0-100 psig up to 0-6500 psig	0-100 psia up to 0-500 psia	0-100 psid up to 0-600 psid
* 46119	0.6 lbs.	0-100 psig up to 0-6000 psig	0-100 psia to 0-600 psia	0-100 psid to 0-600 psid
46139	0.75 lbs.	0-100 psig up to 0-6500 psig	NONE	NONE

Standard Resistance 2,000 ohms. * For Corrosive Media.
For specific values of linearities, resolution, repeatability and hysteresis, write for bulletins.

Giannini INSTRUMENTS CONTROLS

G. M. GIANNINI & CO., INC. PASADENA 1, CALIF. EAST ORANGE, NEW JERSEY

For more information circle **66** on inquiry card.



Look at these features of the Model 604P5 Thermometer Controller

GOOD READABILITY:
indicates temperature on 4½" scale.

QUICK CONTROL CHECK:
readily visible red control pointer and black indicating pointer.

CONTROL AIR CHECK:
front-mounted gauge indicates air pressure to control valve.

VARIETY OF CONTROL:
direct or reverse acting pneumatic control —either on-off or proportional action.

SELECTION OF RANGES:
23 different temperature ranges, up to 1000°F., in Fahrenheit and Centigrade calibrations, for vapor and mercury bulb systems.

COMPACT DESIGN:
die cast aluminum case 11" x 11", 4" deep; gasketed black plastic cover; practically splashproof. Interchangeable flush or surface mounting on panels of any thickness.

SIMPLE SETTING:
external knob for adjusting control point.

A new, low-cost temperature controller *from Honeywell*

MANY processes which now use manual control can utilize the advantages of automatic operation at unusually low cost—by employing the new Brown Pneumatic Thermometer Controller.

For the scores of ovens, vats, dryers and similar equipment which need only temperature indication and relatively simple control, this new instrument affords excellent control performance. It's fast, accurate . . . and simple in design. It takes so little space that it can fit readily into existing equipment or on panels.

Instrument and thermal system are complete in one package. The set point is easily adjusted by means of an external knob. The selection of control actions, ranges and types of thermometer bulbs covers literally hundreds of control applications throughout industry.

In spite of its low price, this controller is a precision-built instrument which incorporates many of the long-lasting, high-quality components used in other Honeywell products. And it's backed by Honeywell's nationwide service organization, strategically located in more than 90 principal cities of the United States and Canada.

Our local sales engineer will be glad to discuss how this new controller can be applied to your own temperature problems. Call him today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4482 Wayne Ave., Philadelphia 44, Pa.

● **REFERENCE DATA: Write for your copy of new Bulletin 6401.**

MINNEAPOLIS **Honeywell**
BROWN INSTRUMENTS
First in Controls

For more information circle **67** on inquiry card.

AVAILABLE NOW! from Stock

TRINITY THERMOWELLS

—in a wide variety of designs, sizes and materials.

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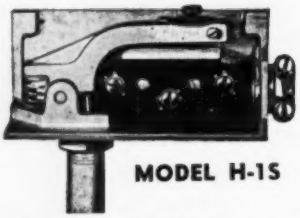
TRINITY EQUIPMENT CORPORATION
494 Westfield Ave., East Roselle Park, New Jersey
THERMOWELLS and other Specialties for the Process Industries

For more information circle **68** on inquiry card.

Temperature Limit Controls



MODEL H-1S

The Burling Model H-1S is approved by Factory Mutual Laboratories as a high temperature safety alarm or cut-out. It is used on ovens, furnaces, dryers, and similar equipment. Snap-action switch may be manual reset type.

Features of Other Burling Controls

- Ranges from -300°F. to +1800°F.
- Electric or Pneumatic
- One, two or three Micro Switches
- Differential Expansion of Solids No liquids—no gases
- Explosion and waterproof housings

Send For Bulletin 101

Burling Instrument Co.
9 Vose Ave.
South Orange, N. J.

Burling TEMPERATURE Controls

For more information circle **69** on inquiry card.

CARGILLE AIDS FOR YOUR DEPARTMENT

LABELS,

Consecutively Numbered, Self-Adhesive. For numbering objects in sequence more neatly, more uniformly, faster and without error. Fine for numbering photographic transparencies. Write for Sample L-1.

TRANSPARENT PLASTIC BOXES

For keeping small objects under cover, in orderly arrangement, yet completely visible. Various sizes. Write for Leaflet TPB-1.

LEAKTEC,

For Detecting Leaks in Gas Lines, Refrigeration and Air Conditioning Systems, or any pressure system. Adopted the past year by hundreds of industrial plants. Write for Leaflet LT-1.

Other specialties for Microscopists, Mineralogists and Chemical Research. State your interest.

Cargille

117 Liberty Street, New York 6, N. Y.

For more information circle **70** on inquiry card.

as needed. Initial conversion: replacing deflection-plate terminal boards with new plug-type terminal boards. Rewiring consists in changing 14 solder connections. Converter can then be used by plugging it in when needed, and unplugging returns 'scopes to normal single-beam operation. Jumpers between proper terminal posts permit several modes of dual sweeping. *Computer Control Co., 106 Concord Ave., Belmont 78, Mass.*

For more information circle **271** on inquiry card.

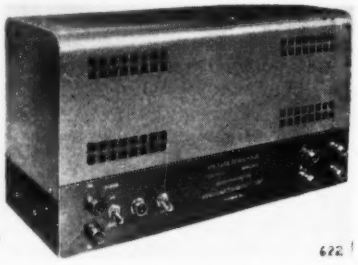
Decade Inductors

New laboratory-precision decade inductors feature instrument-type low-resistance rotary selector switches, powdered molybdenum Permalloy cores, toroidal construction to eliminate external magnetic fields, high Q on all ranges and wide usable frequency range on all four units. Inductance ranges: "Type 101" 1-10 mh., "102" 10-100 mh., "103" 100-1000 mh., "104" 1-10 h. Accuracy within 1 percent.—*Torocoil Co., 1374 Mobile Court, St. Louis 10, Mo.*

For more information circle **272** on inquiry card.

Precision A-c. Regulator

New "Model 116-A" precision a-c. regulator for 400-cycle supplies has rms. output voltage adjustable, with



regulation to 0.01 percent up to half rated load (50 va.) and to 0.02 percent up to full rated load (100 va.), with allowable input voltage fluctuations of 10 percent about adjusted output level, and frequency fluctuation of 5 percent. Recovery time from transients is less than 0.01 sec. Developed harmonics are less than 1 percent. —*Avion Instrument Corp., 291-50 State Eighway 17, Paramus, N. J.*

For more information circle **273** on inquiry card.

Emergency Power Supplies

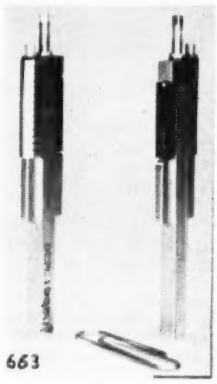
New "Types 5060A and 5070A" emergency a-c power supplies provide up to 250 watts of 110-volt a-c. power from 24- or 48-volt storage batteries for applications where a-c. operated equipment (carrier, etc.) cannot be

interrupted for even short intervals. Automatic transfer to emergency source is completed within 0.5 sec. after failure of normal a-c. power. Load can be returned to normal source either automatically or manually when power is restored. Supplies can be either wall-mounted or installed on 19-in. relay rack.—*Lenkurt Electric Co., 1105 County Road, San Carlos, Calif.*

For more information circle **274** on inquiry card.

Recording Galvanometers

New "Series 7-300 Recording Galvanometers" are said to combine improved techniques of balancing and a completely redesigned suspension sys-



663

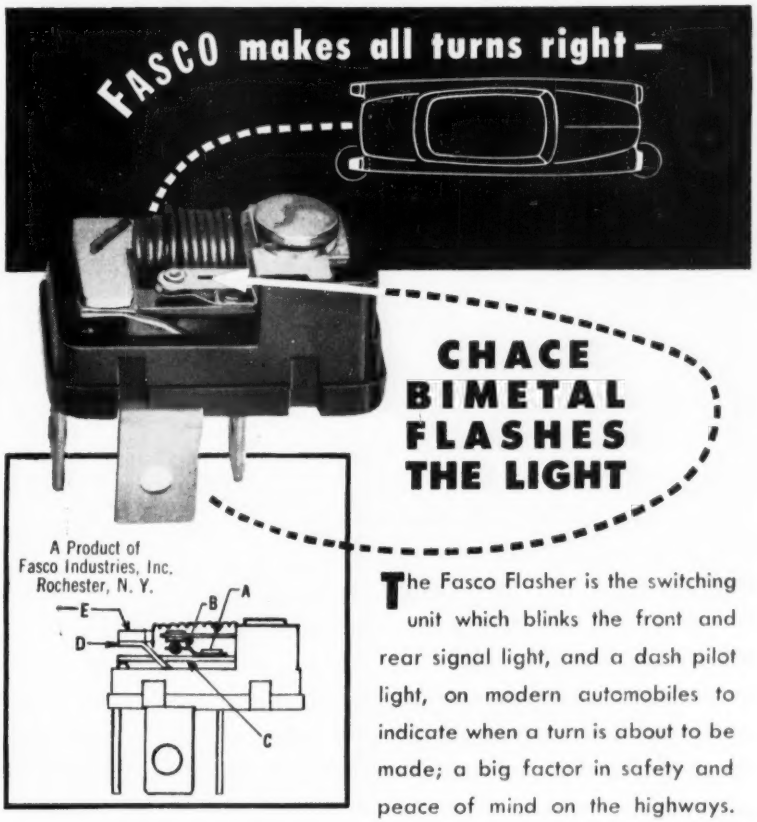
tem to give rigid control over linearity, sensitivity, damping balance, and zero stability. Fourteen models offer flat frequency ranges from 0-11 cps. to 0-3000 cps. Undamped d-c. current sensitivities range from 4.6 microamps per inch to 40 milliamps per inch, both figures representing deflection of a trace on the record at an 11.5-inch optical distance. Electrically, the new units are interchangeable with maker's "Series 7-200" and may be used in all current recording oscillographs. Installation and adjustment are said to be accomplished with greater ease than possible with previous types.—*Consolidated Engineering Corp., Pasadena 15, Calif.*

For more information circle **275** on inquiry card.

Frequency Divider

New improvements are announced in "Decavider 100-1" (high-speed counter for extending range of stand-

ard 100,000-cps. counters to 1 Mc). One improvement is an output circuit providing square waves at one-tenth of input frequency. Another output circuit furnishes sharp positive- or negative-going pulses having a rise time of 0.25 usec. at an amplitude of 40 volts. Counters that require



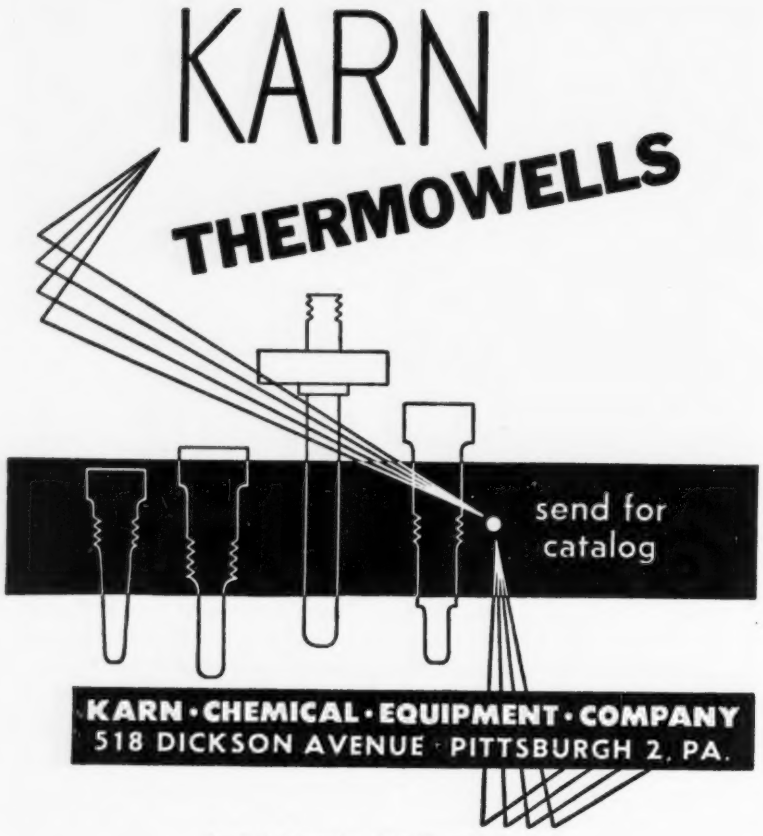
The Fasco Flasher is the switching unit which blinks the front and rear signal light, and a dash pilot light, on modern automobiles to indicate when a turn is about to be made; a big factor in safety and peace of mind on the highways. Fasco flashers are installed as original equipment in many leading makes of cars and trucks.

Heart of the Fasco flasher is a Chace Thermostatic bimetal element which serves a dual purpose—making and breaking the signal light circuit and also protecting the wiring from short circuits and overloads.

In the illustration, the slotted element (A) closes the signal circuit contacts at (B), magnetically energizing frame (E) which pulls up armature (C) against pilot contact (D), lighting the dash pilot light and adding to the upward pressure on blade (A). Signal lamp current flowing through blade (A) causes it to heat and bend upward, breaking the lamp circuit and allowing (B) and (C) to fall and break the pilot light circuit. As (A) cools and touches (B) again, the cycle repeats.

Chace Thermostatic Bimetal is precision manufactured in 29 types, in strips, coils, random long lengths and welded or brazed sub-assemblies. Before proceeding with the design of your new actuating device, consult our application engineers, recognized authorities on temperature responsive devices—or write today for our 32-page booklet "Successful Applications of Chace Thermostatic Bimetal," containing condensed engineering data.

For more information circle **71** on inquiry card.



For more information circle **72** on inquiry card.

ALFAX UNIVERSAL RECORDING PAPER

For the first time there is available an indelible recording paper—ALFAX—that is NOT subject to humidity, temperature of capillary action problems usually associated with pen and ink or papers marked by arcing or heat.

ELECTRICITY IS THE INK THAT MARKS ALFAX

Alfax paper can be marked by current as low as one volt and is instantaneous, permanent and stable. Highly sensitive Alfax is capable of fourteen steps by simply varying the current through the paper.

Alfax is the only paper that is capable of high speed recording, stable before or after recording, is non-transferable, has low current consumption at high speeds, can record at high humidity over all temperature ranges, is smudge proof and non-toxic, widths from ¼" to 72".

Alfax opens a whole new field of monitoring and recording of phenomena which never before have been done easily and cheaply.

THIS MONTH'S EXAMPLE

Recording Directly Cathode Ray Tube Phenomena—One group using a new recorder employing Alfax Paper reports to us that they have been able to reproduce terrain, shore lines, harbors from cathode ray tube information in many cases better than photography.

Request Booklet—describe your problem

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Alden Research Center, Westboro, Mass.

ENGINEERING SERVICE TO RECORDER MANUFACTURERS

For more information circle **73** on inquiry card.

HARDNESS TESTING...

done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 47 years.

In general use for specification purposes. Simple, sturdy Comparatively inexpensive.

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The Shore Instrument & Mfg. Co., Inc.

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For more information circle **74** on inquiry card.

NEW INSTRUMENTS

polarized sharp pulses will respond to new unit's pulse output.—*Decade Instrument Co., Box* 153, *Caldwell, N. J.*

For more information circle **276** on inquiry card.

Current Transformer

New "Type FWO" through type current transformer for outdoor service uses biased core principle and Hipersil cores for high accuracy with smallest practical size and weight; is available in 200-, 400-, and 800-amp primary current ratings.—*Westinghouse Electric Corp., Box* 2099, *Pittsburgh* 30, *Pa.*

For more information circle **277** on inquiry card.

Battery Eliminator-charger

New "Model 1050" combined 6-volt and 12-volt battery eliminator and charger is offered in kit and wired form. It is designed for use in servicing and demonstrating auto radios, marine and aircraft equipment, and for charging 6- and 12-volt storage batteries. Among features: continuously-variable output voltage, separate voltmeter and ammeter, safe operation.—*Electronic Instrument Co., Inc.,* 84 *Withers St., Brooklyn* 11, *N. Y.*

For more information circle **278** on inquiry card.

Flashlight Battery

New "No. 210 Size D Industrial Flashlight Battery" is designed for heavy-duty use. Announcements states that results of National Bureau of Standards tests credited 27 percent more service to "No. 210" than to next leading brand; tests after 6 and 9 months showed an even greater comparable increase. Unit is sealed in steel and plastic and made of artificial ores developed by maker.—*Burgess Battery Co., Freeport, Illinois.*

For more information circle **279** on inquiry card.

ELECTRICAL AND ELECTRONIC COMPONENTS

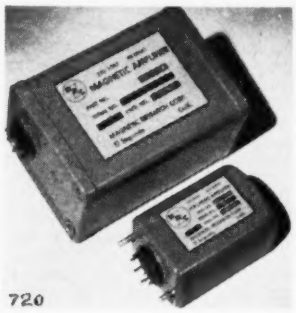
Magnetic Amplifier

New "Model M-21 Miniature High-gain Magnetic Amplifier" produces a usable d-c. output from an input signal as small as 0.2 microampere; features linear current gain of 200 up to 30 microamps input; delivers one d-c. milliamp. with an input of 5 microamps into a 100-ohm load. Power gain has been measured as 50,000; zero drift is less than 10^{-15} watt. Unit for 60-cps. operation measures 2.25 x 2.25 x 3 in. High gain for small size is made possible by a new push-pull circuit with two cores in place of conventional four. Price is said to be "less than one-third that of available magamps with equivalent characteristics."—*Rubissow Electron Research Laboratories,* 119 *W.* 63*rd St., New York City.*

For more information circle **280** on inquiry card.

Magnetic Amplifiers

New high-performance magnetic amplifiers for standard 400-cps. servomotors are especially designed to meet high temperature requirements. No



rectifiers are used. Output wave form is sinoidal, phase reversing, corresponding to input. Signal may be ac. or dc. All models are controlled by a 12AU7 tube which also serves as a demodulator for ac. input signals. Units are hermetically sealed to MIL-T-27 specs.; meet stringent requirements in aircraft and missile control systems.—*Dep't GW, Magnetic Research Corp., 318 Kansas St., El Segundo, Calif.*

For more information circle **281** on inquiry card.

Twin Power Triode

New "Type 6AS7G" high-perveance twin-power triode for voltage regulation (used as a series or passing tube in regulated power supplies) incorporates design changes to offer: (1) absence of grid current; (2) plate current and GM characteristics held within 10 percent; (3) low microphonics; (4) improved triode balance and reduction of plate current drift.—*Chatham Electronics Corp., Livingston, N. J.*

For more information circle **282** on inquiry card.

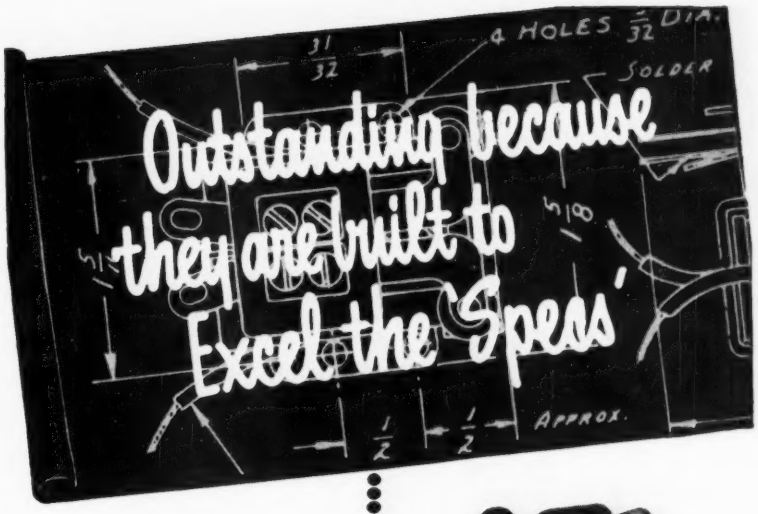
Pulse Transformers

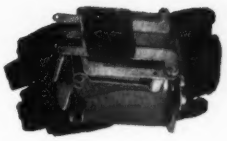
New miniature (¾ x ¾ x ¾ in.) pulse transformers, for computers, telemetering systems, etc., are encapsulated in color-coded thermosetting resin; temperature range —65 C. to 125 C. Standard units will faithfully reproduce pulses with rise times as short as 0.02 usec. and widths as long as 2 usec.; standard primary inductances 150 to 2000 microhenries.—*Electronics Production Service Co., 871 Washington St., Canton, Mass.*

For more information circle **283** on inquiry card.

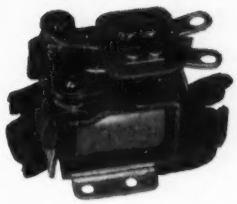
Computer-type VDRs

New "Type 9 Ultra-Low-Torque Potentiometer" is 0.875 in. in diameter, features operating torque as low as 0.015 in.-oz. New structural feature is use of a precision-machined aluminum housing for toroidally-wound resistance element. Individual VDR cups are 0.5 in. long: a five-cup single-shaft assembly is 2.81 in. long including

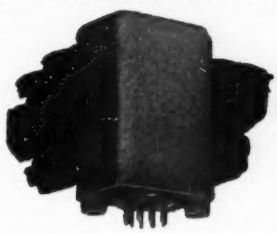




R 45 SERIES—Small telephone type relay with pin hinge construction. Available with multiple contact springs up to six pole double-throw. Capacities: 1 amp., 3 amp., or 5 amp. Normally supplied for D.C. operation. Hermetically sealed or open. 1-13/32x1-1/4x1-7/32 to 1-5/8 high.



R 83 SERIES—Available with A.C. or D.C. coils. Contact ratings up to 30 amperes continuous, 150 amperes inrush with single pole double-break arrangement. Multiple contact springs with proportionately lower ratings also available. Size: 1-7/8x1-5/16x1-5/8 high.



R 94 SERIES—Hermetically sealed small telephone type relay with pin hinge construction for long life. Available in D.C. only with contact springs up to 4 pole double-throw. In 1 amp., 3 amp., or 5 amp. capacity. Plug-in or solder terminals. Overall size 1-5/8 x 1-1/32 x 2-1/4 D.

RB 45 SERIES—Similar to R 45 with the exception that it is designed to fit the hermetically sealed enclosure shown. Three stud mounting; solder terminals. Available up to 4 pole double-throw. Widely used in aircraft and ground communication equipment. Size: 1-5/8 x 1-7/16x2-1/32 D.

"Diamond Quality" TIME SWITCHES...

Automatic Electric also produces a complete line of Time Switches and Timers, both manual and automatic reset. Write for information.

AEMCo

Automatic Electric MFG. CO.

58 STATE STREET MANKATO, MINN.

For more information circle **75** on inquiry card.

Is this your soldering problem, too?

Higher Speed with Smaller Tips?

The answer is—

HEXACON

SUPER POWERED SOLDERING IRONS

Solder Faster with Lower Tip Cost! For example, Cat. P-214 has more speed than conventional 200 watt iron, but takes ¼" tip instead of ⅝" *(only 1/6th the copper).*

SIX MODELS TO CHOOSE FROM

Tip Dia.	Watts	Cat No.	List Price
1/4	100	P-114	$8.25
1/4	150	P-154	9.00
1/4	200	P-214	10.00
3/8	200	P-238	10.00
1/2	200	P-212	10.00
3/8	300	P-338	13.25

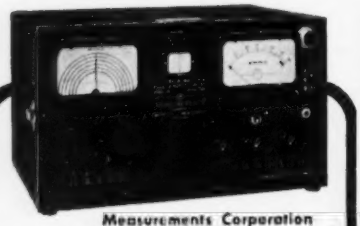
Write for Catalog showing 40 industrial soldering irons of every type and size; no obligation.

HEXACON ELECTRIC COMPANY

179 WEST CLAY AVENUE, ROSELLE PARK, NEW JERSEY

HEXACON — Industry s No. 1 Soldering Iron

For more information circle **76** on inquiry card.



Measurements Corporation MODEL 58

UHF RADIO NOISE & FIELD STRENGTH METER

Frequency Range
15 Mc. to 150 Mc.

FREQUENCY ACCURACY: ±2%. Individually calibrated dial.

SENSITIVITY RANGE: 1 to 100,000 microvolts. Direct reading dial.

POWER SUPPLY: Built-in supply, 117 volts AC, 6 volts DC.

MEASUREMENTS CORPORATION

BOONTON NEW JERSEY

For more information circle **77** on inquiry card.

FOR ALL-AROUND LABORATORY WORK *there are no finer presses than* WABASH

● Models from 3 Ton to 50

Precision construction, sturdiness, convenience and dependability are reasons for the popularity of Wabash hydraulic laboratory presses. With such quality features as chrome plated columns, precision bored guide holes, parallel platens, sturdy hydraulic jacks and many others, they are outstanding in quality—yet reasonably priced.

USE THEM FOR . . .

- Plastic forming, molding
- Extrusion Tests
- Laminating
- Card & Badge Laminating
- Vulcanizing
- Transoptic Specimen mounting
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- Pressing out oils, waxes, etc.
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- Drawing and Forming
- Dehydrating
- Breaking Tests
- Crushing Tests
- Spring Testing
- Adhesive testing
- Liquid-Solid Separation
- Pressure filtering
- Juice, sap extraction
- Vaccines, vires pressing

We'll be glad to tell you more about WABASH presses and what we have to offer

The NEW 30 Ton Model

WRITE TODAY TO . . .

WABASH METAL PRODUCTS CO.

WABASH, INDIANA

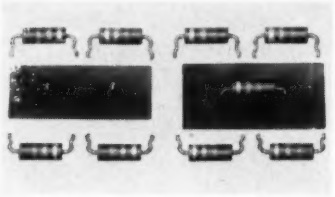
For more information circle **78** on inquiry card.

base and cover. Toroidal resistors permit electrical rotation angles up to 360 deg. and a multiciplicity of taps on any resistor element can be made, each electrically welded to a single turn of winding, thus avoiding dead spots. Resistance values from 50 to 150,000 ohms; standard linearity tolerance 0.5 percent but 0.2 percent can be maintained.—*Electro-Mec Laboratory, 21-09 43rd Ave., Long Island City, N. Y.*

For more information circle **284** on inquiry card.

Resistors for Printed Base

New half-watt fixed-composition resistors are available with specially-formed and trimmed hot-tin-dipped leads for assembling components on



standard 0.062-in. printed wiring base. —*Electronic Components Div., Stackpole Carbon Co., St. Marys, Pa.*

For more information circle **285** on inquiry card.

Solid Delay Lines

New solid ultrasonic delay lines, for video integration, computers, time markers, etc., utilize fused quartz as a delay medium; 1-3000 usec. delay

time can be provided; frequency range 5-100 Mc.; spurious response to 60 db below desired signal.—*Specialties Div., Laboratory for Electronics, Inc., 75-4 Pitts St., Boston 14, Mass.*

For more information circle **286** on inquiry card.

Miniature Delay Cable

New "Type HH-2500" delay cable is a compact (0.25-in. OD) high-impedance circuit element designed to meet delay requirements in color TV receivers and transmitters, electronic computers, radar and loran systems, pulse forming networks, etc. In many instances, it can replace lumped delay lines at a fraction of their cost. Time delay 0.6 usec. per foot; nominal characteristic impedance 2500 ohms. Supplied in bulk (100-ft. lengths) or in pre-calibrated sections.—*Columbia Technical Corp., 5 East 57th St., New York 5, N. Y.*

For more information circle **287** on inquiry card.

ELECTROMECHANICAL COMPONENTS

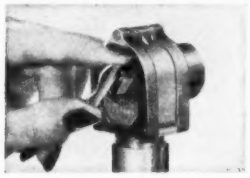
Linear-response Solenoid

New "Linear Proportional Solenoid," originally developed for jet-aircraft fuel-control systems, is made available for other applications. Plunger travel is 0.012 in. plus or minus 0.001 in. for 30-ma. current. Coil resistance is 2900 ohms, plus or minus 5 percent. With a 75-gram compression load on plunger and 0 to 30 ma. current, maximum hysteresis equivalent is 2 ma.—*Connecticut Telephone & Electric Corp., Meriden, Conn.*

For more information circle **288** on inquiry card.

Sealed Power Connectors

New sealed power connectors conform to Signal Corp specs for power units of audio equipment. All plugs are 90-deg. type with wing blade

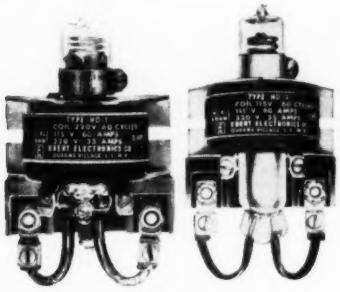


handle operable under conditions in which operator's hand would be gloved.—*Cannon Electric Co., 420 W. Avenue 33, Los Angeles 31, Calif.*

For more information circle **289** on inquiry card.

Heavy-duty Mercury Contactors

New "Models HD-1 and HD-2" mercury relays for heavy-duty control applications are rated 2 hp. at 115 and 230 v.ac., 0.5 hp. at 120 or 240

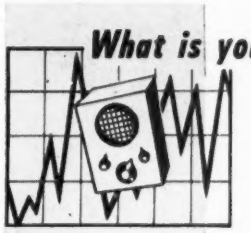


v.dc. Coils are obtainable for a variety of control voltages. "Model HD-1" is N-O; "Model HD-2" is N-C. Both feature mercury-to-mercury contacts and small overall dimensions: 4.25 x 2.62 x 2.25 in.—*Ebert Electronics Co., 212-26 Jamaica Ave., Queens Village 28, L. I., N. Y.*

For more information circle **290** on inquiry card.

Sealed Solenoids

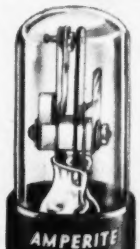
New hermetically-sealed solenoids for continuous 28-v.dc. duty are 1.12



What is your Delay or Regulating Problem?

For the most effective solution use the
SIMPLEST, MOST COMPACT
MOST ECONOMICAL
HERMETICALLY SEALED

AMPERITE
THERMOSTATIC DELAY RELAYS



STANDARD

Provide delays ranging from 2 to 120 seconds.

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
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Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from −55° to +70°C. Heaters consume approximately 2 W. and may be operated continuously. The units are *most compact, rugged, explosion-proof, long-lived, and—very inexpensive!*

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TYPES: Standard Radio Octal, and 9-Pin Miniature.

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- Amperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp).
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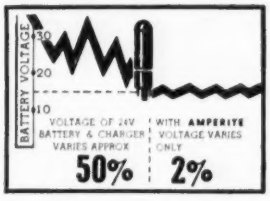

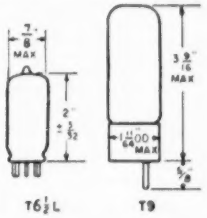

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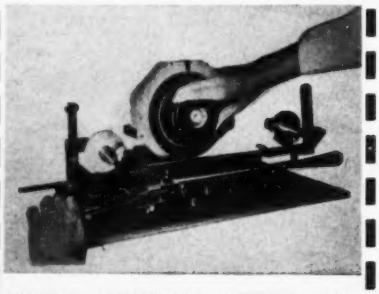

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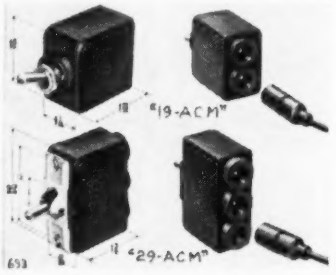
For more information circle **291** on inquiry card.

Waterproof Toggle Switches

New "ACM Series" waterproof toggle switches feature a molded-in female waterproof connector receptacle for assembly with male waterproof

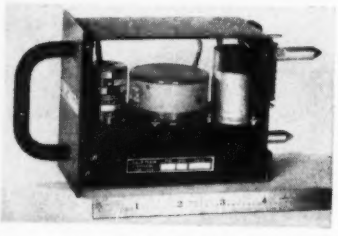


plugs. This obviates need for vulcanizing leads to switch; allows standard switches to be used with any length leads. Both types of switch meet government specs for waterproof toggle switches, operate satisfactorily from −65 F. to 160 F., withstand severe shock and vibration (originally developed for ordnance applications). "19-ACM" is one-hole mounted, with waterproof barrel that obviates need for seal nut or outside panel seal. "29-ACM" is flush-mounting. Either switch is available s-p.s-t. or s-p.d-t. in eight different toggle arrangements, with or without a center OFF position. Capacity 15 amps. at 24 v.dc.—*Riverside Mfg & Electrical Supply Co., 10228 Michigan Ave., Dearborn, Mich.*

For more information circle **292** on inquiry card.

Servo-system Sub-assemblies

New subassemblies of precision servo-system components are available in unlimited combinations, with newly-designed motors, motor-generators,



gear trains, and synchros. Example of new line is illustrated plug-in unit, containing "Type 11M" motor driving voltage divider and "Type 11C" synchro. Rotation of voltage divider is limited by internal stops to 300 deg.; gear ratio is 2.5:1; gears are protected by a slip clutch.—*Transicoil Corp., 107 Grand St., New York 13, N. Y.*

For more information circle **293** on inquiry card.

INSTRUMENT EVENTS Calendar

September 22-December 1
Seventh annual fall series of ten lectures on "Instrumental Analysis—Methods and Applications," sponsored by the North Jersey Section of the American Chemical Society, Tuesday at 7 p.m., Summit Research Laboratories of the Celanese Corp. of America, Summit, N. J. For information write Dr. Alden Hay, Celanese Corp. of America, Summit, N. J.

October 28-30
Perkin-Elmer Southern Infrared Symposium in cooperation with the Gulf Coast Spectroscopic Group. Lee Circle Building Auditorium, New Orleans, La. For information contact S. G. Lindsley, Perkin-Elmer Corp., Rm. 263, Lee Circle Bldg., New Orleans, La.

October 30-31
Annual meeting of Pacific Coast Section, Society of Exploration Geophysicists, Statler Hotel, Los Angeles, Calif. For information write SEG, Box 7248, Tulsa 18, Oklahoma.

November 5-6
Eleventh Annual Pittsburgh Diffraction Conference, Pittsburgh, Pa. Write for information to Dr. H. R. Letner, Mellon Institute, Pittsburgh 13, Pa.

November 9-12
Conference on Radio Meteorology, Austin, Texas. For information write Kenneth C. Spengler, Executive Secretary of American Meteorological Society, 3 Joy St., Boston 8, Mass.

November 13-14
Annual I.R.E. Electronics Conference and Exhibition, Hotel President, Kansas City, Mo. For information write D. L. Welborn, 1400 Chestnut, Kansas City, Mo.

November 18-20
American Institute of Electrical Engineers Conference on Electronic Instrumentation and Nucleonics in Medicine, New York, N. Y. For information write Raymond C. Mayer Associates, 9 Rockefeller Plaza, New York.

November 19-20
Third Annual Instruments Short Course at Los Angeles Harbor Junior College. For information write Edward A. Reps, Southern Counties Gas Co., Box 2736 Terminal Annex, Los Angeles 54, Calif.

November 30-December 5
24th Biennial Exposition of Chemical Industries at Commercial Museum and Convention Hall, Philadelphia, Pa. For information write 24th Exposition of Chem. Industries, 480 Lexington Ave., New York 17, N. Y.

December 7-10
Midyear meeting of Laboratory Apparatus, Laboratory Equipment, and Optical Sections, SAMA, Boca Raton Club, Boca Raton, Fla.

December 8-10
American Institute of Electrical Engineers Computer Conference, Washington, D. C. For information write Raymond C. Mayer Associates, 9 Rockerfeller Plaza, New York.

February 4-6, 1954
Sixth Southwestern I.R.E. Conference and Electronics Show held in Tulsa, Okla. Headquarters in Tulsa Hotel. For information contact Dallas R. Davis, P. O. Box 4185, Tulsa, Okla.

March 1-5
Fifth Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy at William Penn Hotel, Pittsburgh, Pa. For information contact R. G. Russell, Gulf Research & Development Co., P.O. Drawer 2038, Pittsburgh 30, Pa.

March 22-25
Institute of Radio Engineers Conference and Exhibit, Kingsbridge Armory, New York, N. Y. For information contact W. Copp, 1475 Broadway, New York 36, N. Y.

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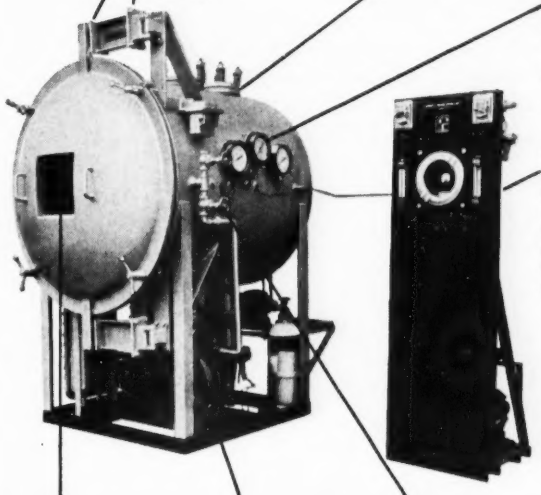

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Fig. 1. Dr. Meggers, looking into the Fabry-Perot interferometer, sees a pattern of circular fringes similar to the enlarged photograph in the background. The Hg-198 is in the discharge tube supported vertically to the left of the lens.

Fundamental Units ar

All measurements are based on units and standards, which change as new principles of measurement lead to ever higher accuracies of measurement.

UNITS FOR MEASUREMENTS should be uniform throughout the nation and the world and constant through the years—imagine the difficulties which would result if a Westinghouse volt were twice as big as a General Electric volt, or if the length of a 1953 inch differed from that of a 1939 inch by as much as do the purchasing powers of the corresponding dollars. However, among the fundamental units and standards currently in use, changes have occurred recently, and others are impending.

Units of Length

The basic units are of length, mass, and time. Today and probably for the next ten years, the fundamental *unit of length* is the distance between two lines engraved near the ends of a platinum-iridium bar which is preserved with great care in the vaults of the International Bureau of Weights and Measures at Sévres, France. Measurements of length in terms of this unit can be made with an accuracy of one or two parts in 10 million. This accuracy is limited primarily by the widths of the lines on either the primary standard or the secondary standards which are being compared with it.

Methods using optical interference patterns (Fig. 1) have come into wide use for accurate length measurements, particularly those involving end standards and gages. The accuracy of measurements by these methods can be higher than with line standards. Many years ago Michelson determined the relation between the meter and the wavelength of the red radiation of cadmium. Since then several other experimenters, using more accurate methods, have determined this relation to the full accuracy of which the line standard is capable. More recently even better light sources have become available for interferometric work. The most interesting of these is the mercury isotope, Hg^{198}. The spectrum lines produced by this isotope are exceedingly sharp and free from fine structure so that interference can be observed over long path differences. This material seems almost ideally suited as a wavelength standard because, owing to its heavy atomic mass, the Doppler widening of the spectrum lines at any given temperature is small. The vapor pressure at room temperature is enough to give a brilliant source which can be excited by an electrodeless discharge using a high-frequency electric field. A vigorous competitor is the isotope of krypton, Kr^{84}. When operated at liquid-air temperatures, this also gives exceedingly sharp lines, although the brightness is somewhat less than that of the mercury isotope.

The International Conference on Weights and Measures has already approved the substitution, as the fundamental unit of length, of the wavelength of some suitable atomic radiation in place of the physical standard, the meter bar. The International Committee on Weights and Measures has appointed a special committee to consider the practicability of defining the meter in wavelengths of light, to decide which isotopic radiation would be best, and to specify in detail the conditions for its excitation. When this committee reports, the meter bar may be considered a secondary standard; the fundamental unit of length, though still called "one meter," may become a specified multiple of the wavelength in vacuum of a chosen radiation. Note that this fundamental change in the definition of the unit of measurement will not change its size, but will increase the accuracy of all future measurements.

Hg^{198} can be obtained in adequate supply by placing pure gold foil in an atomic-energy reactor, where it is exposed to the intense neutron flux. After some months' exposure, enough neutrons will be captured to transmute an appreciable fraction of the gold into the mercury-198. This can then be distilled off and obtained free from contamination by the other isotopes which are present in normal mercury.

Another change took place some years ago in the units of length in the English system. For many years the relation between metric and English units was fixed by the relation:

$$39.37 \text{ inches} = 1 \text{ meter},$$

all digits after the 7 being assumed to be 0. This established 1 inch as being equal to 25.4000508 millimeters. However, an exact factor 25.4 is so convenient in gear ratios and screw threads that in 1933 an agreement was arranged (under the auspices of the standardizing institutions of 15 industrial nations, including Great Britain, Canada, and the U.S.A.) to adopt 25.4 as the exact figure relating the inch to the millimeter for industrial purposes. The legalization of this for all measurement purposes has been held up because there is a conflicting interest in the field of surveying. No one would really mind a change of one part in a million in the size of a plot of ground. However, the U. S. Coast and Geodetic Survey has established with the highest precision a coordinate system, centered somewhere in Kansas, in terms of which land surveys throughout the U. S. are expressed. For regions remote from the center, as in Seattle, Washington or Portland, Maine, even this

Presented at ISA Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, March 26, 1953.

ts and Standards

by FRANCIS B. SILSBEE
National Bureau of Standards

Fig. 2. The ammonia "atomic clock." Dr. E. U. Condon (left) shows Dr. H. Lyons a model of the ammonia molecule. The hollow, rectangular waveguide spiralled around the clock dial contains the rarified ammonia gas. The pattern on the oscilloscope shows the variation in the energy absorption in the ammonia cell as the frequency is swept through the resonance value. See article by Dr. Lyons in the February 1949 Instruments, pages 133-135, 174.

slight change in the unit would shift each plot of land by several feet. The correction of millions of deeds and other legal documents would be an impossible task; consequently the surveyors understandably decline to abandon their 39.37 in favor of the machinists' 25.4.

Units of Time

The second basic unit is that of time, or its reciprocal—frequency. The present unit of time is the *mean-solar-second.* This is an imaginary quantity computed by astronomers from their observations of the times of transit of a fixed star across the meridian; any one such observation can be made with an accuracy of a few milliseconds. The carrying out of such observations is the primary function of the U. S. Naval Observatory in Washington, D. C. From one clear night to the next, the unit of time is carried along by quartz crystal oscillators, groups of which are maintained both at the Observatory and at the National Bureau of Standards. The precision with which time intervals can be measured by the use of such oscillators is

$$\triangle t = \pm(2.10^{-8}\ t \pm 1 \text{ microsecond})$$

Note that the clock is far more precise than the astronomers' measurement, but that the rate of any given crystal must be based upon astronomers' observations taken over an extended period during which the crystal can be assumed to maintain a constant rate. The resulting situation is one common in the field of fundamental measurements—namely, the precision with which a unit can be maintained for moderate lengths of time and with which standards embodying it may be compared is materially greater than the accuracy with which the unit can be realized in the first place and verified at long intervals.

Frequency

The precision possible in the measurement of frequency has been pushed to a high order in recent years. The present standard frequencies emitted from station WWV are precise to one part in 50 million, and the standard oscillators by which the emissions are monitored are themselves accurate to one part in 300 million. The earth itself is not as good a time keeper as this—relative to its average rotational speed, in 1870 it was fast by one part in 20 million, and in 1900 was slow by one part in 50 million. Radio engineers, therefore, are now demanding greater accuracy in frequencies than the poor old earth can supply. We are now hopeful that this demand can be met by some form of "atomic clock," in which the standard of frequency is that of some molecular or atomic vibration.

One such arrangement (Fig. 2), which is more properly called a molecular clock, is based on the fact that ammonia gas molecules are capable of absorbing energy from an electromagnetic field at a particular frequency (23,870 Mc./s.). An energy quantum of this particular frequency is capable of causing the nitrogen atom in the ammonia molecule to undergo a quantum transition from one side to the other of the plane containing the hydrogen atoms. This absorption of energy can be used by suitable electronic circuits to regulate the frequency of oscillating circuits and hence to control a clock. Such a system has been operated at the National Bureau of Standards continuously for a week at a time without changing in frequency as much as one part in 50 million—despite deliberate and severe variations introduced into the operating conditions. A more elaborate apparatus using a beam of cesium atoms is theoretically capable of giving an accuracy 100 times as great and is now in development.

It seems probable that frequency standards of these types will come into general use in many branches of scientific and engineering work. It then will be relatively easy to maintain a check on the fluctuations in the rate of rotation of the earth, which astronomers hitherto could detect only by painstaking and long-continued observations. However, I think we can rest assured that the mean solar second which will keep our clocks in step with day and night will continue to be the recognized unit of time, although not of frequency, far into the foreseeable future.

Unit of Mass

In contrast to length and time, the unit of mass shows more inertia, and no changes in it can be anticipated for a long time. To produce an atomic standard of mass which would be analogous to optical wavelengths and molecular frequencies, means must be developed for counting the number of atoms or protons in a macroscopic block of material. As there are approximately 10^{23} atoms in one gram of hydrogen, such a counting procedure would be exceedingly difficult. Perhaps an alternative procedure for counting electrons and thereby obtaining an atomic unit of electric charge would be easier; even this appears impractical. Fig. 3 shows a high-precision balance for comparing 1-kilogram masses.

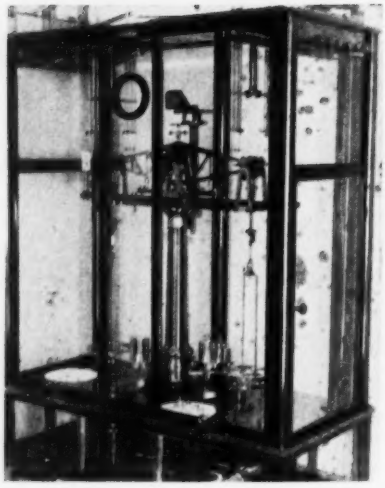

Fig. 3. High-precision balance for comparing 1-kilogram masses. Note mechanism for interchanging masses from one balance pan to the other, and rods for remote operation of arrestment and riders. (These permit observer to remain at a distance so that the heat of his body does not affect the weighing.)

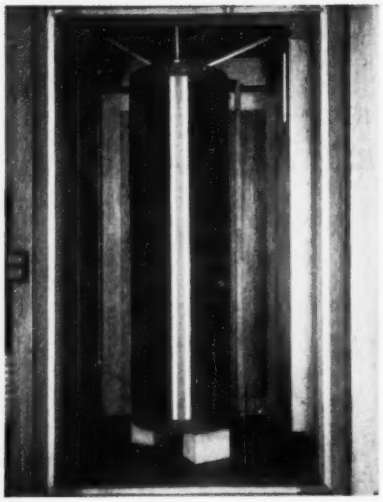

Fig. 4. Standard self-inductor used for the fundamental absolute measurement. It is wound on a glass form 35 cm. in diameter and 100 cm. in length. Its inductance is approximately 103 mh. Enclosing metal-free wooden case protects coil against temperature changes.

Unit of Force

Closely related to the unit of mass is the unit of force. This is because by far the most convenient and accurate means for measuring a force is to compare it with the gravitational force acting upon a known mass. The problem thus involves a determination of the acceleration of gravity, g. For many purposes, sufficient accuracy can be obtained by using a nominal or conventional value for this factor. By general agreement for metrological purposes, the standard value of g is 980.665 cm./sec.^{2}. This figure is a close approximation to the value of g at 45 deg. latitude and at sea level. This standard value is commonly used in tabulations relating horsepower to kilowatts, etc.

For more accurate work it is necessary to use the actual value of g at the place where the force is to be measured. The classical basis for obtaining such a value is the extensive work done at Potsdam in 1906 by Kuhnen and Furtwangler. By use of portable precision pendulums, or more recently of gravimeters, which are operated successively at Potsdam and at the other station at which the value of gravity is desired, it has been possible to establish a network of gravity stations all over the world with values which are mutually consistent to about one part in 10 million. However, the absolute measurement at Potsdam was not as accurate as this. Later experiments by Heyl in Washington in 1936 gave a value smaller by 20 ppm. than that derived from Potsdam. In 1939 measurements by Clark at Teddington, England gave a result smaller than the Potsdam value by 14 ppm. A re-examination by Dryden in 1941 of the Potsdam work led him to conclude that a more reasonable basis for computing the original data obtained at Potsdam would lead to a final value less than the earlier published value by 12 ppm. By combining all available data it may therefore be concluded that for precise work a value smaller than the Potsdam value by about 15 ppm. should be used. All precise measurements of g hitherto have been made by means of reversible pendulums. Volet at the International Bureau of Weights and Measures has currently in progress an independent determination using a freely-falling body. The results of his work are awaited with interest.

Electrical Units

The electrical units are not fundamental, but can be derived from those of length, mass, and time by assuming a conventional value for the permeability of space, μ_0. One way of expressing the interrelations between the electrical and mechanical units is that they must fit two conditions. The first is that the electrical watt should equal the mechanical watt. This condition fixes the *product* of the volt and the ampere. The second condition is that in a rationalized system the unit of resistance must be such as to make the wave impedance of empty space numerically equal to $\mu_0 c$, where c is the velocity of electromagnetic waves. This condition fixes the ohm and thus the *quotient* of the volt and the ampere.

International Units

The actual experiments by which the ohm and the ampere are determined in the laboratory so as to satisfy these conditions are difficult and time-consuming. Consequently, for a period from 1894 to 1948, use was made of an auxiliary set of units known as the International System and "representing the above and sufficiently near to them to be adopted for the purpose of electrical measurements and as a basis for legislation." These words are quoted from the report of the London Electrical Congress of 1908. These international units were defined by the resistance of a column of mercury of specified mass and length and by the rate of deposition of silver from a silver-nitrate solution.

The electrical units could be easily established by such procedures to a few hundredths percent. However, scientific and industrial progress early in the 20th century brought about a need for higher accuracy. At the same time it became evident that accuracy approaching 10 ppm. is no more difficult to obtain by the original absolute measurements than by those on which the International System was based. Accordingly, in 1946 the International Committee on Weights and Measures formally announced the abandonment of the International System and the putting into use effective January 1, 1948 of electrical units based on absolute measurements.

Absolute Measurements

There are two types of absolute electrical measurements. In the first type of experiment an inductor (either self- or mutual-) is constructed of such form and size that its dimensions can be readily measured with high accuracy (Fig. 4), and its inductance is computed from those dimensions and from a conventionally-assumed magnetic permeability of the surrounding space. This inductor then is used in an electric circuit supplied with a periodically varied current, and the effective reactance of the inductor at the known frequency of the current is compared with the resistance of a standard resistor. The result of the process is the determination of the resistance of the standard resistor in terms of length, frequency, and permeability.

In the second type of experiment, a pair of coils of known dimensions is constructed and arranged so that the force or torque exerted between them when carrying a current can be measured precisely. This apparatus is called a *current balance* (Fig. 5). In use it is connected in series with a resistor whose value in absolute ohms is known. The voltage drop in the resistor is opposed to the electromotive force of a standard cell. As a result of this type of measurement the value of the electromotive force of the standard cell can be computed in absolute volts.

Continued on page 1548

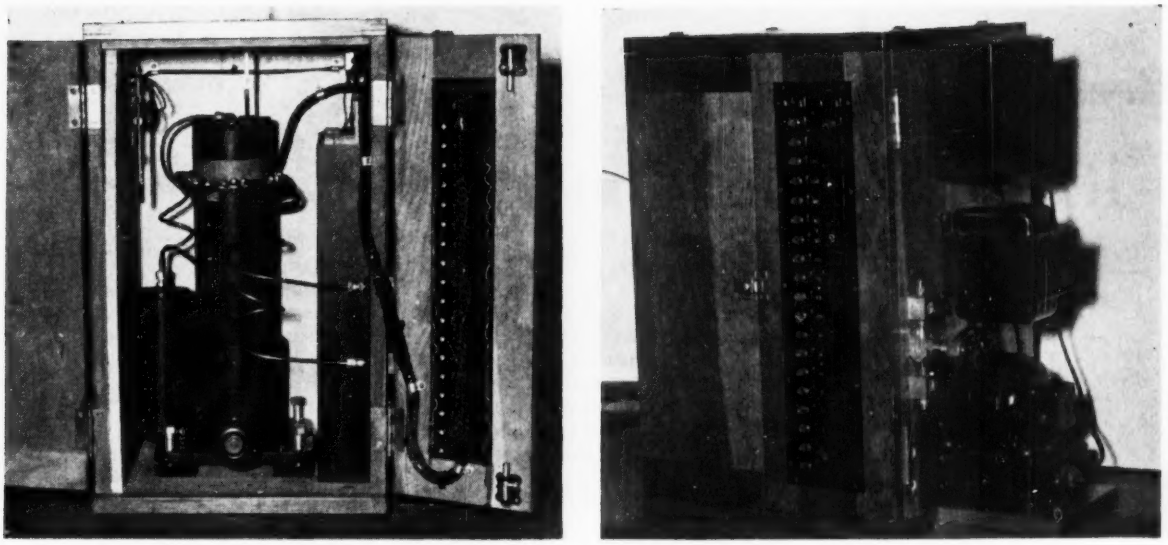

Fig. 1. The high-pressure differential manometer. A (left) view with doors of cabinet open. B (right) view with doors closed.

HIGH-PRESSURE DIFFERENTIAL MANOMETER

By F. B. NEWELL
Taylor Instrument Cos.

A new high-pressure differential manometer uses a series of contacts and neon lamps to indicate small pressure differentials at pressures up to 1500 psi.

HIGH-PRESSURE differential manometers are instruments for measuring a comparatively small pressure difference between two high pressures, such as, for example, 100 inches of water differential with the lower pressure at 1000 psi. The manometer to be described was designed and constructed for testing aneroid manometers and differential-pressure transmitters for errors such as calibration, hysteresis, nonlinearity, repeatability, pressure-level compensation, and ambient-temperature compensation, especially at high pressures.

Several articles have been written on this subject.[1, 2, 3] This manometer, however, differs from those described. It does not give a continuous indication of the pressure differential, but shows accurately by a light signal when certain predetermined pressures have been reached.

The actuating liquid (mercury) makes contact with a series of pointed wires, thus closing the circuit through a series of small neon lights. (Manometers and barometers of the electric-contact type have been used as test standards for many years and have been found to be accurate, reliable, and convenient; some of the barometers have contact wires sealed into the walls of the glass tube; some of the manometers have micrometer depth gages for measuring the height of the mercury.)

The high-pressure manometer (Fig. 1) had to be built to withstand a pressure of 1500 psi. It has at least five contact points within each of the following ranges: 20, 50, and 100 inches of water. The instrument is shown mounted in its cabinet in Figs. 1A and 1B. Fig. 2 shows a section through the main body. Basically, it is a center-tube cistern-type manometer using mercury and having a series of adjustable contact wires, each one set for a certain pressure. It has a thick outside wall to withstand the high pressures, and a zero-adjusting device. It is kept in a small constant-temperature cabinet which has a circulating blower, heaters, and a thermostat. When the pressure outside the center tube increases above that in the center tube, mercury flows up the tube and makes contact with the wires, thus closing the circuits through the small neon lamps.

The center tube is attached to the thick outside wall at its upper end and is raised a little from the bottom at its lower end to permit the passage of mercury. The contact wires are supported by a disk which is attached to the upper end of a center rod so that any elongation of the outer shell due to the high pressure has no effect on the readings. Each wire is cut to approximately the desired length and pointed. The final adjustment is made with the nuts on the fine thread at its upper end so that it will make contact with the mercury at exactly the desired pressure. The wires are kept from touching each other or the walls by spacing rings.

Considerable space is allowed over each mercury surface so that if the differential pressure becomes too great, the air will bubble through the mercury but will not carry drops of mercury out of the manometer and into the connecting tubing. An additional mercury trap is connected to the low-pressure side because its volume is much less than the other.

Continued on page 1553

by E. J. BURTON

British Iron & Steel Research Association *

Recent Advances in

Radiation and Immersion Pyrometry

Recent advances in radiation and immersion pyrometry include (1) a reflecting-hemisphere radiation pyrometer for measuring surface temperatures of ingots, molds, and forgings in the range of 300 to 900 deg. C., (2) a tungsten-molybdenum thermocouple immersion pyrometer for measuring liquid-steel temperatures up to 1850 deg. C., and (3) a fixed-focus narrow-angle mirror pyrometer for measuring total radiation from furnace flames.

POST-WAR YEARS have been marked by a sharp increase in quantity and quality of instrumentation in the steel industry. The high cost of fuel has made managers acutely aware of the importance of measuring temperatures accurately, and demand for special products has led to increased production of high-quality steels which need careful heat treatment with a tight specification on temperature control.

Reflecting Hemisphere Pyrometer

In heat treatment the surface temperature is the only unknown factor required for complete knowledge of the thermal state of the material, because the center temperature can be calculated from this and the physical constants of the metal. Unfortunately, surface temperature is particularly difficult to measure—contact methods disturb the thermal equilibrium; radiation techniques give a temperature depending on the surface emissivity, which can vary from 0.7 to about 0.95 for the different oxides on steel surfaces.

Drury, Perry, and Land[1] have devised a simple radiation method of measuring surface temperatures in which the effect of emissivity is made negligible by increasing the emitted radiation to that of a black body at the temperature of the hot surface. This is achieved by placing a highly polished reflector on the surface; a radiation detector measures the nearly-black-body radiation emerging from a small aperture in this reflector. The instrument (Fig. 1) measures temperature to about $\pm\frac{1}{2}$ percent in the temperature range 300 to 900 deg. C. and is now in commercial production*.

The radiation detector, a Kipp (Moll type) or Hilger-Schwartz thermopile, receives radiation through a small 0.2-in.-dia. hole at the top of the reflector (a hemisphere of 2-in. diameter). The hemisphere is made from steel and plated with platinum to give a reflectivity of about 0.95. The platinum plating is protected against deterioration by a thin coating of silica. The pyrometer was designed primarily to measure the temperature of large forgings or ingots cooling in cold surroundings. Developments are extending the method for temperatures inside furnaces.

Effect of Surface Emissivity

The increase in emissivity which results from the application of the reflecting hemisphere has been calculated theoretically. A surface of emissivity 0.5 is increased to 0.91 by the reflector. The errors in temperature measurement on surfaces of different emissivities are given in Table 1. At 400 deg. C. a change of emissivity from 0.5 to 0.9 changes the temperature error from −7 to +7 deg. C., at 800 deg. C. the temperature error changes from −12

* Presented by Dr. H. T. Clark, Jones & Laughlin Steel Corp., at the 1953 Conference on Instrumentation for the Iron & Steel Industry, Pittsburgh, Pa.

* British Patent 681835, American patent applied for.

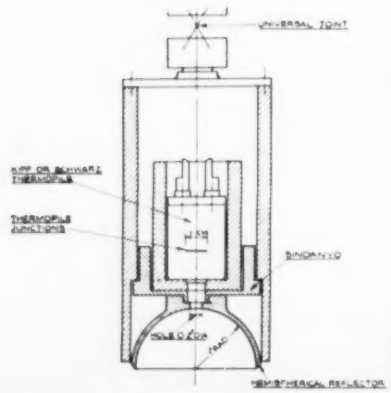

Fig. 1. Plated hemisphere pyrometer.

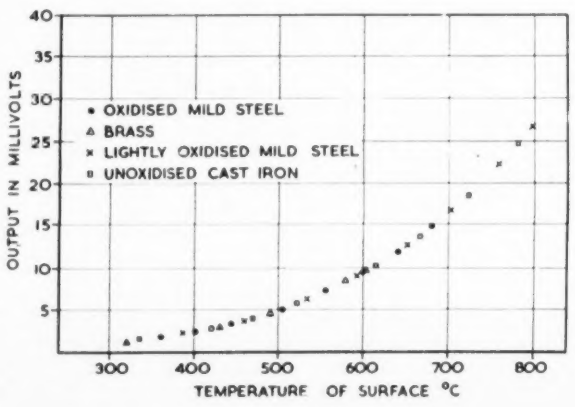

Fig. 2. Calibration of total radiation pyrometer on different metal surfaces, with reflector using Schwarzt thermopile.

to +11 deg. C. The reflector was assumed to have a reflectivity of 0.9 and the pyrometer to read correctly for a surface with an emissivity of 0.65.

TABLE 1.—ERRORS IN TEMPERATURE MEASUREMENT OF SURFACE PYROMETER CAUSED BY VARIATION FROM STANDARD EMISSIVITY.

Surface Emissivity	*Effective Emissivity*	*Error in deg. C. based on True Temperature.* 400°C.	600°C.	800°C.	1000°C.
0.4	0.81	−15	−19	−23	−27
0.5	0.91	−7	−9	−12	−14
0.6	0.94	−2	−2	−3	−3
0.7	0.95	+2	+2	+3	+3
0.8	0.98	+5	+7	+8	+10
0.9	0.99	+7	+9	+11	+13

The pyrometer was calibrated on four different surfaces to test the effect of surface emissivity. The surfaces used and their total emissivities were as follows: lightly oxidized mild steel 0.5, oxidized mild steel 0.8, cast iron 0.8, and brass 0.6. The composite calibration curve shown in Fig. 2 using the Schwartz thermopile illustrates that the pyrometer reading is substantially independent of emissivity and that the theoretical predictions are confirmed.

Effect of the Reflector on Surface Temperature

A hot steel block cools rapidly in cold surroundings. Thus, when an area of its surface is covered by a reflector and the heat loss under it is reduced almost to zero, the local temperature of the surface rises, provided that the initial flow through the block is uniform over a distance comparable with the dimensions of the instrument. If the reflector is left on the surface for a time, the temperature of the surface at the center of the covered area will equal that previously existing at a depth equal to the radius of the covered area. However, the temperature does not immediately rise to its maximum value; the rate of rise is given in Fig. 3A for several surface temperatures. Thus with a pyrometer response of 5 seconds (using the Moll-type thermopile as receiver) 900 or 1000 deg. C. represents the maximum temperature which can be measured accurately. The total temperature rise is reduced by decreasing the diameter of the reflector but, as shown in Fig. 3B, the disturbance is not much reduced in the first few seconds.

The rise in surface temperature of a steel block on application of the pyrometer was determined experimentally; the results are given in Table 2. They agree with the theoretical values up to about 500 deg. C.; above that temperature they are lower.

TABLE 2.—RISE IN TEMPERATURE OF SURFACE AFTER APPLICATION OF PYROMETER

Temp. before Application of Pyrometer (deg. C.)	*Rise (deg. C.)* After 5 sec.	After 10 sec.	After 15 sec.
300	1	1	2
500	2	2	3
800	8	9	14

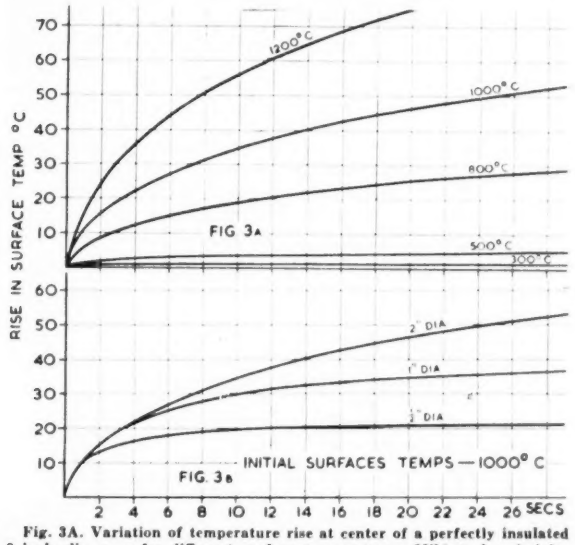

Fig. 3A. Variation of temperature rise at center of a perfectly insulated 2 inch. dia. area for different surface temperatures. Mild-steel emissivity is assumed to be 0.7; conductivity is 0.06 cal./sq. cm./sec./deg. C.

Fig. 3B. Variation of temperature rise at center of a perfectly insulated area for insulators of different diameters.

TUNGSTEN-MOLYBDENUM IMMERSION PYROMETER

No temperature-measuring instrument has proved more useful in recent years to the British Steel industry than the platinum vs. platinum-rhodium immersion pyrometer. Routine measurement of liquid-steel temperatures with the platinum couple protected by a silica sheath is now well established[2], and detailed research[3] on the effects of contaminants has enabled workers to obtain an accuracy of ± 3 deg. C. at 1600 deg. C. The noble-metal couple is generally restricted to a maximum temperature of 1650 deg. C. and to dip readings.

Continuous measurements of liquid-steel temperatures and of combustion-air temperatures in the open-hearth furnace would assist greatly in reducing operating costs. Again, the use of oxygen in a steel melting furnace raises the temperature well above the melting point of platinum. A review of high-temperature thermocouples suggests that the tungsten-molybdenum combination could be used to supplement the platinum vs. platinum-rhodium couple and, therefore, its thermoelectric properties were examined.[4]

Laboratory Calibration

The tungsten-molybdenum thermocouples were made of 0.3-mm.-diameter wire. The hot junction was made by twisting the molybdenum wire tightly around the tungsten for four or five turns, as suggested by Potter and Grant.[5] The junction was then welded by a d-c. arc using a tungsten electrode.

For calibration the thermocouples were placed in alumina sheaths and heated in a graphite furnace. The temperature of the tip of the sheath was measured with a disappearing-filament pyrometer; a preliminary comparison against a platinum vs. platinum-rhodium couple in the alumina sheath confirmed that the temperature of the thermocouple equalled that measured by the optical pyrometer.

A typical curve of emf. against temperature for a tungsten-molybdenum thermocouple over the temperature rage from 0 to 1800 deg. C. is shown in Fig. 4. At the low temperatures the thermocouple temperature was measured by

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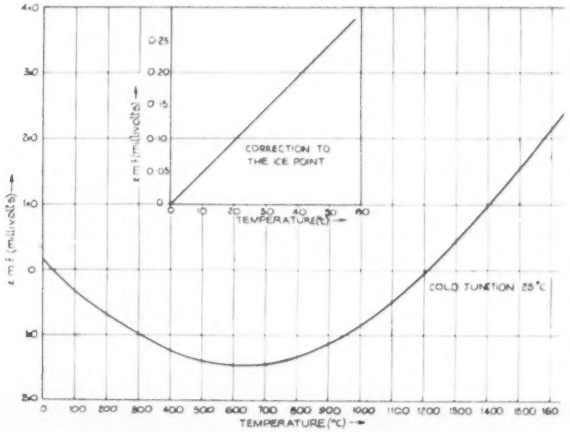

Fig. 4. Calibration curve of a tungsten-molybdenum couple.

AUTOMATIC CALIBRATION OF TRANSDUCERS

By J. F. KINKEL and R. R. MAWSON
Consolidated Engineering Corporation

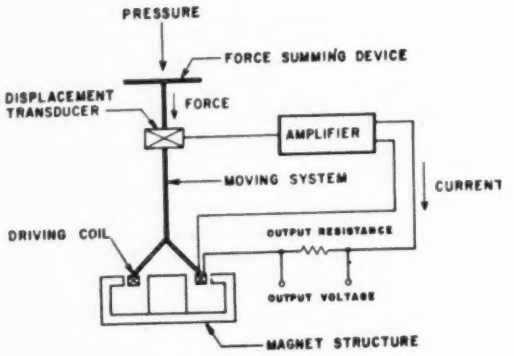

Fig. 1. Diagram of pressure balance.

A system of automatically calibrating pressure, force, and acceleration transducers to an accuracy of 0.1% over a large temperature range relies on the dynamic force-balance principle for its pressure, force, or acceleration reference, and includes either analog or digital presentation of the data. Test time is reduced by a factor of seven.

CALIBRATION of transducers generally involves the evaluation of two sources of error—internal errors resulting from an imperfect response to the measured stimulus, and external errors resulting from response to environmental conditions or stimuli other than the one to be measured. In addition, the response to the measured stimulus may be a function of environment.

A pressure pickup, for example, has internal errors expressed as nonlinearity, hysteresis, set, and drift, all of which are functions of the environment and history of the pickup, while external errors result from response to changes in temperature and acceleration. Therefore, the instrumentation required for transducer calibration consists of means for measurement and control of the measured parameter, measurement and control of the environment, measurement of the transducer response, and presentation of the data.

The calibration results usually are presented in terms of deviations from desired response. Use of electromechanical devices in a closed-loop servosystem permits automatic computation of deviations and results in greater accuracy, improved reliability, and considerable saving of time. The calibration system described by this article relies upon the dynamic force balance as the standard of measurement for pressure, force, and acceleration.

CALIBRATION STANDARD

The dynamic force balance is a self-balancing magnetic force-balance type of instrument, suitable for the measurement of pressure, force, and acceleration. Having an inherent accuracy of better than 0.1 percent of full scale, a response time of less than 0.1 second, and an output voltage proportional to input, the dynamic force balance is uniquely suited for use in calibration systems. Because of the low impedance output of 2500 ohms and the full-scale input voltage of ±100 volts d-c., controlling and computing operations are particularly convenient.

The basic instrument consists of a magnet and coil force generator, displacement transducer, and servo amplifier arranged as in Fig. 1. A force acting upon the moving system displaces it, causing an input to the amplifier from the displacement transducer. The resulting current output of the amplifier flows in the driving coil with such magnitude and polarity that the magnetic force exerted on the moving system by the driving coil balances the externally applied force. Therefore, under equilibrium conditions, the magnetic force equals the input force, and the output voltage produced by the current in the output resistor is a measure of the applied force.

The instrument is readily adaptable to pressure measurements by the addition of a force-summing device (Fig. 1) for conversion of pressure to force. Similarly, addition of a mass to the moving system for the conversion of acceleration to force produces an accelerometer.

BASIC CALIBRATION SYSTEM

Most calibrations of transducers require the measurement of the pressure, force, or acceleration to a high accuracy, and the calculation of the difference between two large numbers to determine the response of the unit being tested. Measurement of the analog output of the transducer by potentiometer null-indicating devices is the most accurate of these measurements. Measurement of the particular stimulus is the least accurate in most calibration techniques. Not only is the measurement of the stimulus inaccurate, as in determining pressure with a mercury manometer, it is a tedious operation; an all-electronic, fully automatic pressure calibration system is desirable. For

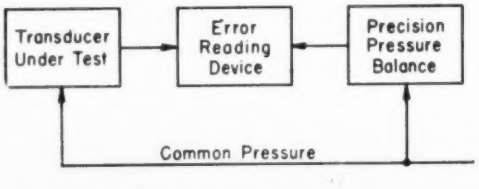

Fig. 2. Basic pressure-calibration system.

*Abstracted from a paper contributed by the Instruments & Regulators Division for presentation at the Semi-Annual Meeting, Los Angeles, California, June 28- July 2, 1953, of the American Society of Mechanical Engineers.

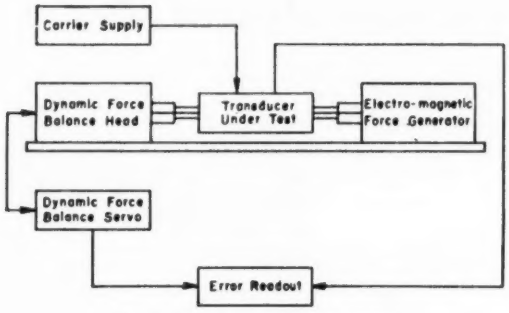

Fig. 3. Basic force-calibration system.

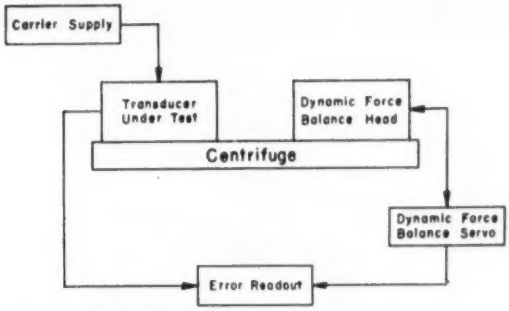

Fig. 4. Basic acceleration-calibration system.

such a system a voltage which is accurately analogous to pressure is necessary. The precision balance fills that requirement.

As the voltage output of the precision pressure balance can be made to equal the voltage output of the transducer at full scale, it is necessary only to compare the two at any pressure and record the difference. In this service the error-reading device need not be extremely accurate because its full-scale indication can be made to equal only a small percentage of the full-scale output of the transducer. Fig. 2 is a block diagram showing the basic components of such a calibration system.

The errors may be presented in either digital or analog form. The most desirable form is a continuous plot of the errors, which can be inspected visually to determine not only the absolute value of the error at any pressure, but the shape of the curve.

The basic system for calibration of force transducers is shown in Fig. 3. The mechanical arrangement is such that the same force is applied to both the transducer under test and the dynamic force balance. As with the pressure calibration system, the difference in outputs of the test transducer and the dynamic force balance represents errors in the test transducer.

Acceleration pickups may be calibrated by suitably mounting both the dynamic force-balance accelerometer and the test transducer on a centrifuge for application of acceleration (Fig. 4).

Fully Automatic System

A fully automatic calibration system (shown on front cover of this issue) has been designed to (1) calibrate pressure, acceleration, and force transducers, (2) provide a basic accuracy of better than 0.1 percent, (3) provide for automatic programming and recording of environmental conditions, (4) read out the data in form suited to facile interpretation and provide a permanent record, (5) provide versatile program preselection, and (6) require no attention during execution of the program as set up.

As this instrument incorporates a closed servo loop, arrangements can be made to regulate the pressure on the test manifold to a desired value as commanded by the insertion of a voltage in the servo loop. The voltage output of transducers under test, or the differential voltage between these transducers and the reference balance, may be read by the "SADIC" analog-to-digital converter to 1 part in 1,000, which also provides contact closures for printing data on tape. For certain kinds of calibration work, an analog plot of the data may be desired. Therefore a plotting board is incorporated in the system.

A small environmental test chamber is included in the system to provide the range of ambient temperatures for which the transducers are to be tested.

A "programmer" integrates the various operations and controls their execution. The programmer (1) controls the environmental test chamber, (2) selects the transducers to be tested in the proper order, (3) selects the proper data presentation for the information obtained and commands the operation of the readout equipment, (4) supplies the necessary control signals to change the magnitude of the measured stimulus, and (5) supplies the necessary signals to identify the data.

The number of pickup calibration channels is 18; the full-scale pressure range is 1.5 to 150 psi.; the time of execution of 1 standard pressure calibration sequence is 12 minutes; the temperature range is minus 100 to plus 300 deg. F.

Zero drift and sensitivity drift with temperature are determined by comparison of the value of absolute zero offset and absolute full-scale sensitivity at various temperatures.

Hysteresis is determined by comparison of deviations from linearity for increasing pressure with deviations for decreasing pressure.

Deviations from linearity ordinarily require the largest time for data reduction with conventional test methods. A block diagram of the fully automatic system appears in Fig. 5.

The system presently in operation has a capacity of 18 transducers. It is essentially a 20-channel system, one channel being used to measure temperature and one for carrier voltage. The system consists of a bridge-balancing facility (which supplies excitation to the transducer and furnishes a means of balancing out any residual zero unbalance of the transducer), the precision pressure balance with its associated electronics, a "SADIC" analog-to-digital

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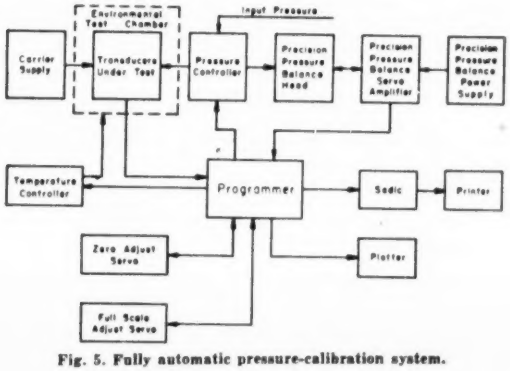

Fig. 5. Fully automatic pressure-calibration system.

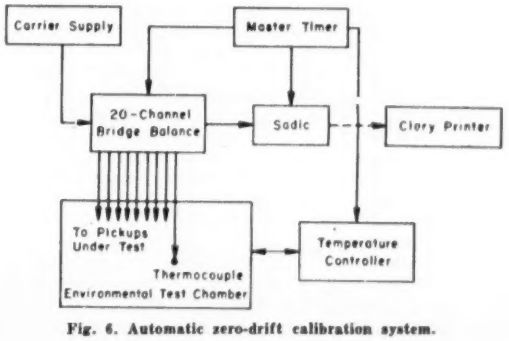

Fig. 6. Automatic zero-drift calibration system.

Nuclear Reactors for Industry and Research

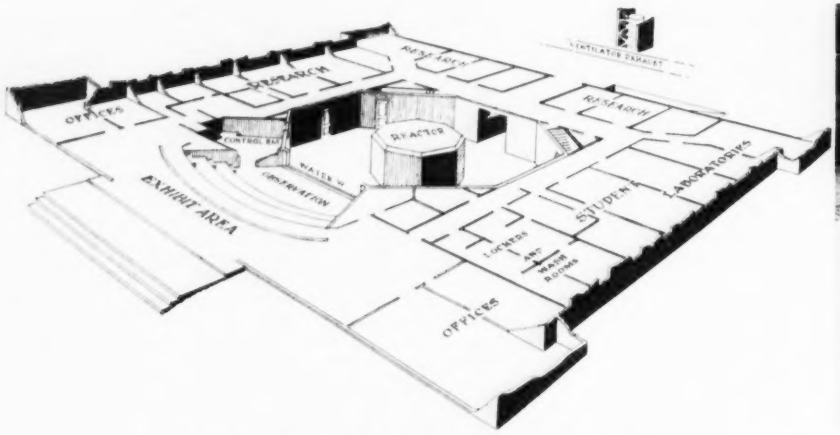

Fig. 2-1. Pictorial plan of Raleigh research-reactor building.

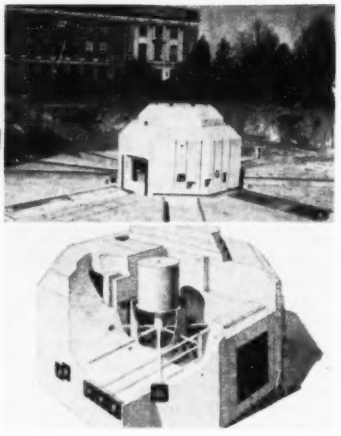

Fig. 2-2. Reactor housing.

II. AVAILABILITY AND SELECTION

A nuclear research reactor can be of great value to a university, a state, a community, or an industry. Selection of a reactor by a university or industry requires consideration of reactor types, function, cost, and facilities.

by DR. JOHN TRIMMER
University of Tennessee

A LARGE university should have as part of its scientific equipment a small nuclear chain reactor for experimental purposes. However, state legislators and the regents of universities are not likely to be easily convinced that they should purchase such a utility. They will act only if they are led to see that (1) a university cannot hope to keep abreast of present-day progress in the important nuclear field without installing a reactor; (2) suitable reactors are available and their installation is not prohibitively costly or complicated and (3) their operation is fairly simple and relatively safe.

Values of Nuclear Chain Reactors

In the nuclear chain reaction, man has tapped a whole new field of energy supply—the nucleus. Sober estimates, based on trends of population and of energy consumption and inventories of nuclear and conventional fuels, show that nuclear fuels are the only known terrestrial resource capable of meeting humanity's increasing energy demand. The sun is indeed a richer available source of power; but practical means for extensive harnessing of solar energy have not yet been devised. The immediate and growing importance of nuclear power has engaged the attention of both industrial and educational leaders.

Nuclear reactors also give to man the large-scale realization of the ancient alchemist's dream—the transmutation of elements. Other devices of the modern physicist, such as the cyclotron, permit transmutation of minute quantities of matter, but from reactors the yield is in pounds. The classic alchemy, changing baser metals into gold, is not a chief goal of the modern alchemists. Their interest centers rather on elements which have heretofore been rare or completely missing, and on the new nuclear varieties (isotopes) of familiar elements. Both kinds of scientific treasure are found in the fission products—the ashes of the nuclear fire—and may be created also by bombarding material with the intense neutron beams available from reactors.

The isotopes thus obtained are all more or less radioactive and so are commonly called *radioisotopes*. Their availability in sizable amounts for application in research and technology is enormously valuable. Their radioactivity provides a tag by which individual atoms may be followed, and "tagged-atom" or "tracer" techniques have been enormously fruitful in science, engineering, and medical research.

Values to the State and the General Region

In a country as large as the United States, there is no single pattern of power needs and fuel availability. Regions and states should be interested in reactor development based on local population density, degree and type of industrialization, and mineral resources. One of the considerations mentioned as prompting Norway to build a reactor was the "thought that Norway, being one of the largest shipping nations but having to import all fuel used for shipping, ought to keep abreast of developmen s in the nuclear power field."

The presence of a reactor in a region is felt in other important ways—the availability of radioisotopes and neutron radiation open new vistas in many aspects of medicine, public health, radiological defense, etc.

Values to the Community of the University-owned Reactor

With increasingly large supplies of nuclear fuel announced by the Atomic Energy Commission, there is every reason for diverting a larger portion from bombs to re-

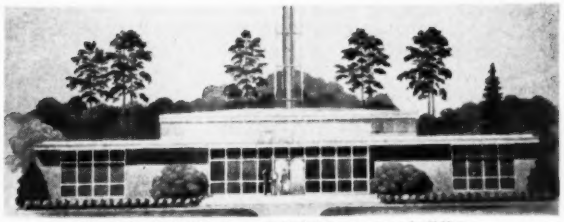

Fig. 2-3. Artist's view of Raleigh reactor building.

actors. There should be many reactors. The dividends to be expected in the art of reactor design itself, as well as in pure and applied science generally, are overwhelmingly worthwhile.

Not only should there be many reactors, but they should be dispersed widely. Pressures of interest and advantage peculiar to localities can shape the art of building and using reactors in desirable diversity. Geographic accessibility can, in turn, multiply the number of persons and institutions benefitting from reactor operation.

There are many reasons for locating the reactor in a university. In addition to the values to the university, there are important values to the community. In the combined process of teaching and research that goes on in a university, there is a unique efficiency in stimulating, producing, and disseminating new knowledge. Nowhere else does investment produce so large a total return. There is, moreover, a much better flow of information from universities to other agencies, such as industry, than there is in the reverse direction.

When there is a wide distribution of reactors among the universities of the country, there will be created a large, diverse group of informed persons (teachers and students) interested in reactors. The various reactor projects will then be under the direction of individuals relatively free of the centralized control thus far characteristic of reactor development. Moreover, if universities should add reactors to their facilities, the need for personnel trained in nuclear technology could be met more fully.

Values of a University-owned Reactor to a University

The primary function of a university is the teaching and training of students in advanced fields of learning. The most important secondary function is the exercise of scholarship and original research in adding to the stores of knowledge. These two functions are closely interrelated. A university nuclear reactor can play a significant role both in teaching and in research.

For the various new college courses being established or considered, availability of a nuclear reactor can be of decisive value. In the whole field of nuclear technology the reactor is the central, the key device, the natural focus around which subsidiary instruments, great or small according to the total scope contemplated, may best be grouped. Teaching of nuclear technology can well begin with study of the reactor itself. It has great intrinsic interest, combining simplicity of basic concept with complex variety of eventual design possibilities.

In addition, the university reactor can add to teaching facilities for other courses, particularly to the laboratory and research work in physical and biological sciences. As a physical system the reactor is an intriguing example for courses in system design, instrumentation, and automatic control.

Research possibilities for a university reactor are already known in great variety, and would presumably be further diversified as more such reactors come into use. In physics, important problems under investigation include neutron diffraction studies, the spontaneous decay of the neutron, study of short-lived radioactivities, effects of radiation on matter, and effect of matter on radiation (shielding studies). In chemistry, the reactor makes possible the study of rare elements, such as technetium and promethium, isolated from fission products; the method of quantitative analysis by irradiation of samples in the reactor; and the study of the effects of intense neutron beams in chemical processes. To

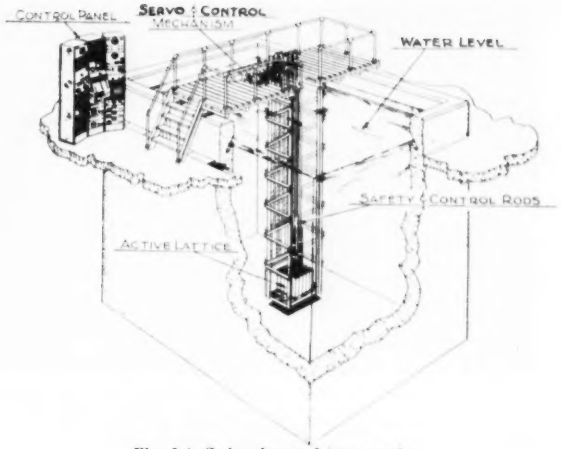

Fig. 2-4. Swimming-pool-type reactor.

the biologist, the reactor makes available intense beams of radiation for studying the effects of radiation on organisms and the possibility of modifying such effects by administration of chemicals.

A challenging problem relating to reactors is the finding of useful applications for fission products. Some actual or suggested uses for the enormous radioactivity available in these chemicals are sterilization (without heating) of foods and drugs, activation of phosphors for luminescent markets, industrial radiography (supplementing x-rays), elimination of static electricity hazards, and various uses in instruments and power supplies. The probability of discovering new large-scale uses for fission products would be enhanced by having large numbers of university personnel in touch with the problem.

In concluding this brief survey of the values to a university of owning a reactor, an alternative scheme now in force is to have large regional national laboratories to which university staff members may go for periods of research and study. This system has limited value in the teacher-student interaction, which is the heart of university life; and it is not efficient for the staff member because it usually involves disproportionately long periods of moving, of adjustment, and of getting work started.

Values of Research Reactors to Industry

The rapidly pyramiding technological complexity of warfare means that industrial and governmental interests in many areas must merge further. The problem is how this merger may be achieved without having industry socialized in fact if not in name. Nowhere is this problem more acute than in the handling of nuclear-energy developments.

When the Atomic Energy Act was written it seemed advisable to keep control of existing plants and of further developments strictly in government hands. Military significance of the fission bomb, which at that time naturally appeared transcendent, dictated this decision. But it is important that the situation be re-examined now for possible ways of opening the future progress in nuclear energy, aside from weapons development, to industrial enterprise. A beginning in this direction has been made by the proposal of joint power- and plutonium-producing reactors, to be operated by public utilities companies. A logical next step would be for private industries to build and use their own research reactors.

The immediate value to an industry of having a private research reactor will depend, naturally, on the nature of the industry. The advantages of having immediate and exclusive use of neutrons for research purposes will in many cases be considerable. It is very important to keep in mind the *two* aspects of such availability—first, the relative advantage over competitors in products or methods directly in the field of nuclear energy, and second, the advantage in products or methods achieved by the use of nuclear research techniques. The former is more completely under government control and therefore less attractive to private

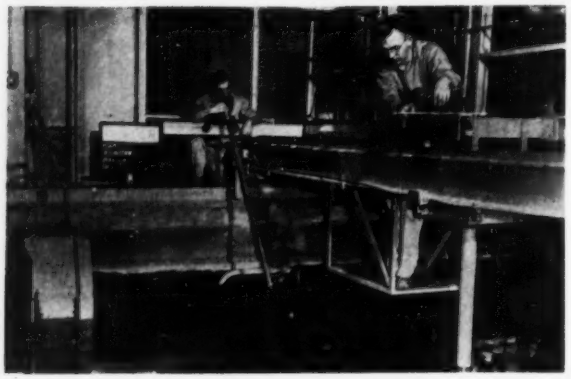

Fig. 2-5. A nuclear reactor of 10-kilowatt power is set up for operation under the water of the "swimming pool" bulk shield testing facility at Oak Ridge National Laboratory. An operator, observing through a telescope, gives directions as another operator locates an instrument to measure neutron flux about 15 feet below the surface. This low-cost low-power reactor, used at Oak Ridge to aid development of improved reactor shields, is a promising type for nuclear investigations at universities and non-AEC laboratories.

initiative. The point is worth illustration by an example. Suppose a chemicals firm, using its own research reactor, develops a radioisotopic compound having some outstanding usefulness. It appears doubtful, under present law, whether the firm could exclusively control the product. But if the reactor or its products were used simply as a research tool in developing an ordinary (non-radioactive) chemical, the firm could expect to reap the full benefit of its discovery. The potential advantage, in such competition, of the availability of short-lived isotopes is a virgin territory for pioneering work.

The possibility of selling part of the reactor's operating time to other plants or laboratories should not be overlooked. Furthermore, there is no cogent reason why the production of marketable radioisotopes should remain a government monopoly. It seems reasonable to visualize a privately financed venture in which a combination of isotope production and experimental reactor time is offered for a price. This kind of project might be inviting as a joint effort of several cooperating companies. It would furnish a way of "getting one's feet wet" without a prohibitive initial outlay and with some prospect of immediate return on the investment.

The cooperation of the Atomic Energy Commission would be needed to assure the private reactor operator that his fair asking price for products and services would not be underbid by government laboratories. If present law does not provide scope for such assurance, the law can be changed. Whether government will move in such directions, however, depends on the vigor and intelligence with which private industry claims its rightful role.

Types of Reactors Available to Universities and Industry

A university or private industry that is considering the purchase of a reactor should make an informed approach to the selection of the design. The important particle in the reactor is the neutron; a reactor may be described as a volume in which there is an abnormally high concentration of neutrons. How is this high concentration maintained? Maintaining it is the role of the chain reaction in which a neutron, on entering a fuel nucleus (uranium or plutonium), causes it to shatter into fragments (usually into two approximately equal parts). What makes the process a *chain* reaction is that two or three fresh neutrons come out of the fission explosion of the fuel nucleus, which neutrons then can go about initiating fresh fissions.

As the average yield of neutrons per fission is about two and a half, the reaction will go on so long as there are fuel nuclei to serve as targets and so long as the neutrons are successfully conserved to the extent of one neutron per fission, which neutron can eventually cause another fission. This chain leads to the "economics of neutrons." Each neutron formed in a fission event inside a reactor can either (1) cause another fission, (2) be parasitically absorbed (with no resulting fission) into some nucleus inside the reactor, or (3) escape entirely from the reactor. The latter two possibilities must be minimized if the chain reaction is to proceed.

Escape of neutrons to the outside of the reactor can be minimized first of all by making the reactor large and thus obtaining a large ratio of volume to surface. (This statement underscores the fact that there is a *critical size* for the nuclear reactor.) Loss of neutrons to the outside can be reduced also by surrounding the active core of the reactor with a *reflector* material, which can give an outgoing neutron a fifty-fifty chance of being turned back. The neutrons not turned back must be absorbed by *shields*, so as to preclude their endangering persons near the reactor.

Non-fission absorption of neutrons occurs in the various materials of which the reactor is made, because the fuel elements are not perfect in yielding one fission per neutron absorbed. In addition, there are materials called "moderators" in most reactors. These are included to slow down the neutrons from the high speeds they have at fission to the slower speeds corresponding more nearly to room temperature, at which the chance of causing fission is greatest. Fortunately, good moderators absorb few neutrons, but even the best (such as heavy water) absorb a few. Neutrons are lost also by absorption into various purely structural parts of the reactor and into the elements used for controlling the reaction.

Neutron Density

If the neutron economy is good enough to keep the chain reaction going, there is the question of the *level* at which it is to be maintained. One can speak here of *neutron density* (the number of neutrons in unit volume) or of *neutron flux* (the total distance traveled, by all the neutrons in unit volume, in one second). Flux is the product of neutron density and average neutron speed, and is measured in neutrons per square centimeter per second. When the flux is large, there will be many fissions per second. With each fission there will be released a relatively large amount of energy. (Some thirty billion fissions per second are needed to make one watt of power; but in a cubic inch of pure solid uranium there are nearly a million billion billion nuclei.) If there are many fissions per second, the reactor will tend to heat up rapidly, and one must provide a *cooling system* for receiving the heat.

Reactor Classifications

Reactors may be classified according to structure or according to purpose. The principal purposes for building reactors have been for research, for power production, and for production of fissionable or radioactive isotopes. Some research reactors generate considerable power, but in general it is the low-power research reactor (the upper limit for this designation might be set at a few hundred kilowatts) which is of most interest to universities.

Classification of reactors according to internal structure involves specification of (1) the kind of fuel, (2) average energy of the neutrons, (3) choice of moderator and reflector materials, (4) nature of cooling system, and (5) arrangement of fuel (either lumped into rods, or homogeneously dispersed, as in a solution). Table 1 in Chapter 1 shows the many varieties of design which are possible.

Typical Graphite Reactor

Under contract from the AEC, a graphite reactor is being designed by The North American Aviation Company (see Fig. 1-1 in previous chapter). Design power is 160 kw., and thermal neutron flux is 10^{12} neutrons per square centimeter per second. Estimated cost is about a million dollars. The fuel is enriched uranium contained in a gas-tight aluminum tank. As the fuel need not be processed for ten years, there is no major waste disposal problem.

Typical Water-solution Reactor

Another popular type of research reactor is the water-solution design, adopted by North Carolina State College for the first university reactor project in this country (Figs. 2-1, 2-2, and 2-3). The fuel is enriched uranium in

Continued on page 1555

INSTRUMENT SOCIETY of AMERICA Journal

National Office: 1319 Allegheny Avenue, Pittsburgh 33, Pa., P V. Jones, Jr., Society Manager.

Vol. 9 OCTOBER, 1953 No. 10

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Section Secretaries, Meeting Data and Programs

AKRON
Russell F. Marquardt, 1782 Tonawanda Ave., Akron 5, Ohio. Tel: ST-6865
Fourth Tuesday, Meeting 8:15 P. M.

ALBUQUERQUE
A. Richard Charlton, 1229 Girard Blvd. N. E., Albuquerque, New Mexico
Second Thursday, Meeting at 8:00 P. M.

ARUBA
M. A. Davidson, P. O. Box 452 c/o Lago Oil & Transport Co. Ltd., Aruba, N. W. I., 2087.
First Tuesday, 7:30 P. M., Engr's Club.

ATLANTA
Roy W. Freeman, Minn.-Honeywell Reg. Co., 1415 Howell Mill Rd., Atlanta, Ga. Tel: AT 9776
Fourth Friday, Meeting 7:30 P. M.

BALTIMORE
G. B. Greer, 631 East 36th St., Baltimore 18, Md. Tel: CHesapeake 6879
Second Friday, Meeting at 8:30 P. M.

BATON ROUGE
Thomas J. Folendore, 1540 Keed Avenue, Baton Rouge, La. Tel: 3-5567
First Monday, 7 P. M.

BLUE RIDGE
David C. Moore, Box 425 B RFD #4, Roanoke, Va.

BOSTON
E. E. Forslind, Stone & Webster Eng. Corp. 49 Federal St., Boston 7, Mass. Tel: Ha-6-2500 Ext. 821.
Fourth Wednesday, Dinner 6:30 P. M. Meeting 7:30 P. M. 99 Club, 99 State St., Boston.

CALIFORNIA
Robert W. Fulwider, 5225 Wilshire Blvd., Los Angeles 36, Calif.
Second Wednesday, Dinner at 6:30 P. M. Meeting at 8:00 P. M.

CAROLINA PIEDMONT
H. M. Messenger, 436 Sedgefield Rd., Charlotte, N. C.
Second Friday, Dinner at 7:30 P. M., Meeting at 8:00 P. M. Cardinal Restaurant, Charlotte.

CENTRAL ILLINOIS
Eric B. Bensing, 1100 Hanssler Pl., Peoria, Ill.
Second Wednesday, 7:30 P. M.

CENTRAL INDIANA
Leon Stewart, Rock Island Refining Corp., P.O. Box 6091, Indianapolis, Ind. Tel: CO-2377
First Tuesday, Dinner at 7:00 P.M. Business Meeting 8:00 P. M.

CENTRAL NEW YORK
C. M. Davies, 213 Beechwood Ave., Liverpool, N. Y. Tel: Syracuse 3-0252.
Third Monday, Dinner 6 P. M. Meeting at 8.

CENTRAL OHIO VALLEY
J. C. Dilliner, 813 Winton Ave., Belpre, Ohio. Tel: Belpre 87596
First Tuesday, Dinner at 7:30 P. M., E.S.T., Hi-Way Grille, Rt. #2.

CHARLESTON
J. A. Rothwell, 310 24th St., Dunbar, W. Va.
First Monday, Dinner at 6:15 P. M., Meeting at 8:00 P. M., Kanawha Airport Terminal

CHICAGO
Floyd E. Ertsman, Rm. 1420, Fisher Bldg., 343 S. Dearborn St., Chicago 4, Ill. Tel: WE 9-0686
First Monday, Dinner at 6:30 P. M., Meeting at 8:00 P.M. Hotel Shoreland, Chicago, Ill.

CHINA LAKE
Beuhring W. Pike, 606-A Essex Circle, China Lake, Calif. Tel: 77782
Third Thursday, Meeting at 8:00 P. M.

CINCINNATI
Richard E. Surkamp, 7347 Richmond Avenue, Cincinnati 36, Ohio.
First Monday, Dinner at 6:30 P. M., Meeting 8:00 P. M., Engineering Soc. of Cinn.

CLEVELAND
R. C. Van Hala, %Van Hala Industrial Co., P. O. Box 2602, Lakewood 7, Ohio
Second Wednesday, Dinner at 6:30 P. M. Meeting at 8:00 P. M.

COLUMBUS
Kenneth I. Lea, Battelle Institute, 505 King Ave., Columbus 1, Ohio Tel: UN-3191, Ext. 247.
Third Thursday, Meeting at 8:00 P. M. Battelle

CUMBERLAND
Clyde Babst, 225 Cecelia St., Cumberland, Md. Tel: 583-W
Fourth Wednesday, Dinner at 6:30 P. M., Meeting at 8:00 P. M.

DENVER
Karl F. Kent, Jr., 5030 Umatilla, Denver 11, Colo. No regularly scheduled meetings. Univ. of Denver, Science Bldg.—Campus

DETROIT
Philip Hill, Minn.-Honeywell Reg. Co., 13681 Plymouth, Detroit 27, Michigan
Third Wednesday, Meeting 8:00 P. M.

EASTERN NEW YORK
Robert W. Carter, Sterling-Winthrop Research Institute, Rensselaer, N. Y. Tel. Albany 5-6251 Ext. 262
First Tuesday, Meeting at 8:00 P. M., Siena College, Loudonville, N. Y.

FOX RIVER VALLEY
John R. Redgrave, 109 S. Appleton St., Appleton, Wis.
First Tuesday, 8:00 P. M.

HOUSTON
A. Costa, 6209 Edloe St., P.O. Box 6614, Houston, Texas.
Last Monday 8 P.M. U. of Houston Library

KALAMAZOO VALLEY
Jack M. Fettig, 433 Thomas St., S.E. Grand Rapids, Michigan.
Fourth Wednesday, 8:00 P. M., Dinner at 6:30 P. M. Meeting at Red Arrow Legion Post.

KANSAS CITY
Donald D. Baker, 5823 Mission Rd., Mission, Kansas
First Tuesday, Meeting at 7:30 P. M., U. of Kansas City, Science Bldg., Rm. 106.

LAKE CHARLES
W. L. Willoughby, 3508 Louisiana Ave., Lake Charles, La.
First Wednesday after last Monday, Dinner and regular meetings at McNeese State

LOUISVILLE
O. Vern Spousta, 2000 S. Brook St., Louisville, Ky.
First Monday, Meeting at 8:00 P.M., Seagram Auditorium.

MILWAUKEE
D. A. Spitz, Froedfert Malting Co., 38th St. and W. Grant, Milwaukee 15, Wisconsin.

MONTREAL
W. L. Toohey, Dominion Textiles Ltd., 1950 Sherbrooke St., West, Montreal, Tel. GI 5711
Last Monday of month, Meeting 8:00 P. M.

MUSCLE SHOALS
Frank W. Potter, T.V.A., Wilson Dam, Ala.
First Thursday, Meeting 8:00 P.M., TVA Chemical Engineering Bldg.

NEW JERSEY
Eliot R. Hill, 1125 Kensington Ave., Plainfield, N. J.
First Tuesday, Meeting 8:00 P. M., Essex House Hotel, Newark, N. J.

NEW YORK
R. A. Hutcheon, 45-65 196th St., Flushing 58, N. Y., Tel: BAyside 9-5432
Third Monday, Dinner at 6:00 P. M., Meeting at 7:30 P. M., Midston House, 38th St. & Madison Ave.

NIAGARA FRONTIER
Duran L. Hagler, 214 E. Delavan Ave., Buffalo, N. Y., Tel: ELmwood 1258
Fourth Monday, Dinner at 6:00 P.M. Meeting at 8:00 P. M., N.Y.S. Technical Institute.

NORTH TEXAS
R. E. Byers, 6000 Lemmon Ave., Dallas 9.

NORTHEAST TENNESSEE
S. E. Abernathy, c/ Equipment Sales Corp., 341-345 W. Market St., Kingsport, Tenn.

NORTHERN CALIFORNIA
George W. Killian, 3718 Ramsey Court, El Sobrante, Calif. Tel: BEacon 4-0523
Third Monday, Meeting 8:00 P M.

NORTHERN INDIANA
J. B. Beckman, 7145 Wicker Ave., Hammond, Ind. Second Tuesday, Meeting at 8:00 P. M., Whiting Community Center, Whiting, Ind.

OAK RIDGE
Thomas M. Gayle, 117 W. Vanderbilt Drive, Oak Ridge, Tenn. Tel: 2-1516.
First Wednesday Meeting at 7:30 P. M.

OGLETHORPE
R. A. Coffield, 2219 E. 39th St., Savannah, Ga.
Second Friday, 8 P. M. Reddy Kilowatt Room, Savannah Electric and Power Company.

PADUCAH
J. B. Russell, Carbide & Carbon Chemicals P. O. Box 748, Paducah, Ky. Tel: 5-6311—Ext. 403
Second Tuesday Dinner at 6:30 P. M. Meeting 8 P. M.

PANHANDLE
George W. Leggett, 1600 Western Ave., Amarillo, Texas.
Third Tuesday, Dinner at 7:30 P.M. Phillips Grade School Cafeteria, Phillips, Texas

PERMIAN BASIN
Jack M. Ray, P.O. Box 1386, Odessa, Texas
Second Tuesday, Dinner at 8 P.M. Tel: 2-2813

PHILADELPHIA
A. S. Chatfield, c/o American Meter Company, 1513 Race St., Philadelphia 2, Pa.
Elks Club, 1320 Arch St., Dinner at 6:30 p. m., program at 7:30. Third Wednesday.

PITTSBURGH
Dr. A. H. Peterson, Mellon Institute, 4400 Fifth Ave., Pittsburgh 13, Pa. MA 1-1100
Fourth Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Roosevelt Hotel

PRESQUE ISLE
F. L. Moore, American Meter Co., 920 Payne Ave., Erie, Pa.
Fourth Tuesday, Meeting at 8:00 P. M.

RICHLAND
J. R. Plee, 1309 Roberdeau, Richland, Wash. Tel: 5-8692
Second Wednesday, Meeting at 7:30 P. M.

ROCHESTER
R. C. Schwarz, Jr., 1201 Granite Bldg., Rochester 10, New York. Tel: Hamilton 1468
Fourth Tuesday, Meeting 8 P.M. U. of R., Bausch & Lomb Physics Lecture Room 109.

SABINE-NECHES
R. A. Block, 2301 Avenue "G", Nederland, Texas
Last Tuesday, Meeting at 7:30 P. M., Orange County Courthouse, Orange, Texas.

SARNIA
L. J. Hall, 730 Talfourd St., Sarnia, Ont., Canada. Tel: EDgewater 2258.
Third Monday, 8:00 P.M., Y.M.—Y.W.C.A.

SAVANNAH RIVER
Secretary, F. D. Reed, 516 Goldman St., North Augusta, South Carolina
Second Wednesday, Dinner at 7:30 P.M. North Augusta Legion Post.

SEATTLE
Frank S. Melder, 2439 76th N.E. Bellevue, Washington, Second Friday.

SOUTH TEXAS
Homer C. Givens, P.O. Box 637, Falfurrias, Texas. Tel: 202
First Thursday, Engineers Club

ST. LOUIS
W. G. Lee, 4710 Delor St., St. Louis 16, Mo. Tel: FL 8516.
First Wednesday After First Monday, Meeting at 8:00 P. M.

TOLEDO
Howard R. Daily, 2025 Scottwood Ave., Toledo, Ohio.
Third Tuesday, Meeting at 8.00 P. M.

TORONTO
John W. Huether, 311 Sutherland Dr., Leaside, Ontario, Canada. Tel: HU-7114
Fourth Thursday, Meeting at 8:00 P. M.

TULLAHOMA
Owedia A. Montgomery, ARO, Inc., GDF Instrument Branch, AEDC, Tullahoma, Tenn. Tel: 636
Second Tuesday, Meeting at 7:30 P. M.

TULSA
A. J. Sesock, 845 South East Ave., Tulsa, Okla., Tel: 8-1112
First Monday, Meeting at 7:30 P.M.

TWIN CITIES
John L. Schmidt, 1879 University Ave., St. Paul 4, Minn., Tel: DR 0064
Fourth Tuesday, Dinner at 6:30 P.M., Meeting 7:30 P. M.

WASHINGTON
Edward C. Lloyd, 2105 Spencer Road, Silver Spring, Md. Tel: SH. 9340.
Third Monday, Meeting at 8:00 P. M.

WAYNE COUNTY
Clarence Ellison, 2443 15th St., Wyandotte, Michigan. Tel: Avenue 2-4178.
Third Monday, Meeting at 8:00 P. M.

WICHITA
J. W. Rieg, c/o Koch Engineering Co., Inc., 321 W. Douglas Ave., Wichita 2, Kansas
Third Thursday, 8 P. M. Scientific Bldg.

WILMINGTON
W. C. Ruglass, 900 A West 8th Street, Wilmington, Delaware
Second Tuesday, 8:00 P. M. Harlan School.

Susquehanna Valley Meets

An organizational meeting of men interested in forming the Susquehanna Valley Section of ISA was held September 15, 1953 in the auditorium of the Armstrong Cork Company, Lancaster, Pa.

Temporary officers of this organizing Section are: President, R. D. Turkington; Secretary, F. C. Belsak; and R. W. Stanford as Treasurer.

ISA NEWS

VICE-PRES. BRAND'S REPORT

The Technical Division has, at the time we approach the annual conference, fourteen (14) active committees. With the exception of the D-2 Committee on Research and Development all the committees named in the Society's By-Laws are operating. Two additional active committees have been added to the by-laws roster of Technical Division committees, the D-14 Aeronautical Instrumentation and the D-15 Computer Data Handling Committees.

W. H. BRAND

As we go into the next conference year there is a great likelihood that the D-2 Research and Development Committee will be in the embryo stage. Delmas Little, present chairman of the D-4 Testing Instrumentation Committee, is passing this post to H. Rondeau after three years of service. Beginning in October, Mr. Little will act as chairman of the D-2 Committee and has already enlisted the cooperation of several Society members who are interested in the operation of such a committee.

The present status of the Technical Division can be attributed in the large part to the continued cooperation of Porter Hart, D. M. Boyd, A. O. Beckman and W. A. Wildhack. All of these men have at one time or another been responsible for Technical Division activities.

It might be of interest to the Society membership to note the size of the present committees: D-1, Technical Program 6; *D-2, Research & Development 4; D-3, Operation & Maintenance 30; D-4, Testing 7; D-5, Analysis 11; D-6, Inspection & Gaging 2; D-7, Production Processes 34; D-8, Transportation 7; D-9, Medical 8; D-10, Meteorological 3; D-11, Radiation 6; D-12, Geophysical 3; D-13, Physical Properties 3; D-14, Aeronautical 2; and D-15, Computer Data Handling 9; to a total of 135.

It is interesting to note that the committees achieve a membership of ten or higher after a few years of operation. The four older committees have a total membership of 82. As the more recently activated committees level out in operation, a Technical Division membership of 260 will probably be conservative.

*Appointed for next conference year

Regional Conference Activities

The Society has for the first time co-sponsored the National Telemetering Conference which was held in Chicago on May 20th-22nd, 1953. The other societies participating were the AIEE, IRE and IAS. Registration of 308 was reported and all attending voted the meeting a definite success. Plans for the 1954 Telemetering Conference call for another meeting in Chicago. The interim planning committee met on August 10th to assign responsibilities for specific functions to each of the cooperating societies. The D-15 Computer Data Handling Committee held their organization meeting during the 1953 conference, naming E. W. Burdette as chairman. The 1954 Telemetering Conference will be a major responsibility of this Committee.

During November of this year our Society will co-sponsor with AIEE and IRE the Sixth Annual Conference on Electronics in Nucleonics and Medicine. Dr. H. J. Morowitz of the D-9 Medical Committee and R. W. Johnston of the D-11 Radiation Committee have attended the organization meetings and will represent ISA in the Conference.

These regional meetings on specific subjects are co-sponsored on a supporting basis with the understanding that the ventures are to be self-liquidating insofar as possible.

Individual Committee Reports

A complete report of the operations of each of our technical committees would make this report very long. In an effort to briefly list the activities the following items are listed and described. Individual committee reports from some of the committees will be included in full in an appendix.

D-1 Technical Program—This committee has been activated less than a year but has produced an enviable record. Under the chairmanship of S. G. Eskin, the Committee has coordinated all technical contributions for the Chicago Conference and in essence has arranged all sessions for maximum reception. A Reporting Sub-committee has been appointed and will for the first time report on efficiency, coverage, and continuity of the technical program presented at the Chicago Conference. Pressure of work has made it necessary for Sam Eskin to withdraw from the chairmanship of this Committee. Neil Blair, who was vice-chairman, has consented to serve as chairman and is currently planning for the 1954 conference. (See Appendix A attached)

D-3 Operation and Maintenance—J. Johnston, Jr. found it necessary to resign as chairman of this committee early in the year. George Larsen has served as chairman since that time, being particularly valuable to the Society because of his experience with the committee and the clinics. The Annual Maintenance Clinic sponsored by the Committee is a part of our Chicago Conference and will be held on the three days preceding the technical meetings. One general session and eight two-hour class sessions will be participated in concurrently by each of three groups. George Larsen and Earl Bush, as well as many other members of the Chicago Section, have done an excellent job in arranging this clinic. The D-3 Committee is sponsoring one technical session on "Turbine Supervisory Control" under the guidance of A. K. Joecks.

D-4 Testing Instrumentation—Delmas Little has with his able assistants arranged the program of five sessions to cover five specific categories. The sixth special session will consist of a panel of eminent speakers discussing "Research and Development." (See Appendix B attached)

D-5 Analysis Instrumentation—The Analysis Clinic is again scheduled for the week of the Conference. Axel Peterson reports that eight sessions of the Analysis Clinic will be conducted concurrently twice a day the 22nd, 23rd and 24th of September. The D-5 Committee is sponsoring one technical session of three papers.

D-6 Inspection and Gaging—This Committee is sponsoring one session of two papers. Chairman of this Committee is T. Marshall of the Pittsburgh Section.

D-7 Production Processes—This Committee is almost deserving of division status since there are 14 working subcommittees. The D-7 Committee met at a dinner meeting in Cleveland last September and had an all day meeting at the Commodore Hotel in New York City on January 17th. Both meetings had attendance of 75 percent or higher. The 1953 Conference has a D-7 Production Processes session of at least three papers every morning of the entire week of the Conference. Chairman —C. A. Hansen, Jr. and Secretary— R. N. Pond are to be congratulated on the quality and consistency of operation of their committee.

D-8 Transportation Instrumentation —This Committee is sponsoring two sessions. One of these sessions will be a joint session including papers contributed from the D-12 Geophysical Instrumentation Group. Chairman J. J. McDonald promises an extremely comprehensive program for the 1954 Conference.

D-9 Medical Instrumentation—The Conference will have three sessions on Medical Instrumentation, with a total of fifteen papers. The EINM Conference scheduled for November of this year will be one of the activities of this Committee. Dr. H. J. Morowitz is serving on the planning committee for EINM, along with R. W. Johnston of

the D-11 Radiation Instrument Committee.

D-12 Geophysical Instrumentation—Dr. S. Kaufman has labored very diligently in an effort to bring this type of contribution to our conference. In spite of difficulty in obtaining contributions from this specialized field of endeavor which is normally reported in geophysical journals, this committee is sponsoring two papers.

D-13 Physical Properties—H. C. Roberts, chairman of the D-13 Committee, has produced a complete plan of operation for his committee and is pursuing an objective program for contribution. Sessions on Physical Properties Instrumentation will include four papers. (See Appendix C attached)

D-14 Aeronautical Instrumentation—O. J. Greenwood has accepted the chairmanship of this Committee and is currently planning an ambitious program for the 1954 Conference. One session of the Chicago Conference program will carry several papers on the subject.

D-15 Computer-Data Handling—This youngest Committee of the Society is actually only four months old at this writing. The organization meeting, at which E. W. Burdette was named Chairman, was held in Chicago in May at the National Telemetering Conference. No sessions will be held at the 1953 Conference. Members of the Committee will be ISA representatives at the 1954 Telemetering Conference schedued for next spring.

Technical Division Meetings

This division has held two chairmens' meetings during the year and has had excellent attendance at each. These are held in conjunction with the Publications Committee and the Society Manager. By joint effort it has been possible to prescribe a paper handling sequence which will improve paper quality and save time. The Publications Committee forms used for the first time this year are improving the received contributions to such a degree that editing and handling are measurably simplified.

The members of the Technical Division serving on committees constitute 2 percent of the Society membership. With this percentage of active participants the Conference proceedings will become and remain a valuable Society product which will establish a new level of professional standing.

Warren H. Brand, Vice President
Technical Division

1953 *Report of Technical Program Committee*

1—The plans for the operation of the Technical Program Committee were formulated in a preliminary manner at the 1952 Conference in Cleveland.

2—The Committee now consists of the Chairman, Vice Chairman, Mr. Neil Blair of Panellit, Inc., and Secretary, P. M. Fleming of the du Pont Company.

3—A Reporting Subcommittee was organized consisting of L. Gess, H. H. Johnson and John J. McDonald. The problem of the Reporting Subcommittee is to observe the operation of the Technical Program at various annual Conferences and report so as to eliminate any difficulties which may take place.

4—The Technical Program Committee asissted in the preparation of various forms for processing of papers.

5—The Vice-Chairman of the Committee was in close contact with the Chairman of the Technical Committees to expedite the flow of information necessary to organize the program for the 1953 Conference.

6—A tentative program for 1953 was formulated at a meeting of the Program Committee and distributed for comments and revisions to the Chairmen of the Technical Committees and others interested in the program.

7—Plans have been made for a meeting of the Technical Program Committee with chairmen of the various Technical Committees during the 1953 Conference to formulate plans for the Technical Programs for the 1954 Conference.

S. G. Eskin, Chairman
Technical Program Committee
Instrument Society of America

Committee on Instrumentation

At a committee meeting held in Cleveland during the 1952 Conference, it was decided that five of the Committee members would take charge of soliciting papers for one session each, with other members lending such aid as they could offer and as might be asked of them, with the Chairman supervising and coordinating the work. The plan has worked very well with the exception of one member, who, because of the pressure of business was unable to carry through with his session. The committee members handled all the correspondence and gave the papers their first review as received. The second review was given by the Chairman.

Later, at the request of various ISA members a session on "Instrumentation in Research and Development" was undertaken, to be in the form of a panel discussion.

After three years, the Chairman has decided to turn the committee over to someone else and has been grooming Mr. H. F. Rondeau, of the Presque Isle Section for his successor. The present chairman wishes to assure the National Officers that Mr. Rondeau is fully competent to handle the Committee, at least as weli as the present chairman, and in all probability, better.

Delmas C. Little, Chairman
Committee on Instrumentation
for Testing

1953 *Report of Physical Properties Committee*

Since beginning its activity, in January of this year, the Physical Properties Committee (D-13) has

Prepared a statement of scope and of aims, and circulated it to individuals and to other committees with whom overlap or conflict might be expected. This statement has, I believe, been approved by all these persons.

Begun enrolling other committee members. Mr. R. E. Wendt, Jr., of the Westinghouse Research Laboratories, East Pittsburgh, has become a member of the committee. Prof. R. W. Jones, of the Department of Electrical Engineering of Northwestern University, will become a member in the near future, I think. I have his tentative oral approval, not final.

Several papers on physical properties and their determination have been procured; of these, four have been completed, received, accepted for ISA use, and sent in for preprinting. One session has been scheduled for the 1953 Annual Meeting.

A policy on paper content (tentative, at least) has been formulated for this committee. It includes a requirement that papers contain some fundamental or theoretical material; that no paper should be no more than a description of a method or an equipment.

I have considered that one of the functions of this committee is education; at least in the specific field of the committee. Since I am also a member of the national Education Committee, there is a convenient overlap. I have also begun the arrangement and scheduling of a two-day (perhaps 2½ days) short-course in Instrumentation for the Determination of Physical Properties and Analysis Instrumentation, in the Chicago Section. (This was intended for the spring just past, but I started too late.) I consider this activity a joint effort to Committee D-13, of the Sub-Committee on Research Symposia of the Education Committee, and of the Chicago Section (of which I am Chairman of the Analysis Instrumentation Committee).

Howard C. Roberts, Chairman
Physical Properties Committee

George H. Gaites

The New York Section reports with deep regret the death of one of their Executive Committee. Mr. Gaites joined the Society in 1951 and served the New York Section in many capacities.

Charles A. Hansen, Jr.

The ISA lost a valued member through the death of Charles A. Hansen, Jr. on September 10th. He was a charter member of the Eastern New York Section which he had served as President. He was 1953 Chairman of the Committee on Instrumentation for Production Processes and had been nominated as Vice President of the National organization for 1954.

VICE-PRES. SHEEN'S REPORT

C-1 Sections & Membership Committee

With chairman Mifflin S. Jacobs of Pittsburgh, Pa., and assistant chairman J. H. Cottrell of Tulsa, Okla., this committee is a most active one. The committee reports a very successful year in its work on assisting in the establishment of new sections and on considerable correspondence with additional prospective sections. The following new sections have been chartered since the last report: Blue Ridge (Virginia); Paducah (Kentucky); Seattle (Washington); Oglethorpe (Savannah, Ga.); Wichita (Kansas); Tullahoma (Tennessee); and Milwaukee (Wisconsin). Our total membership is now over 6900 as of August 15, 1953.

R. T. SHEEN

In accordance with the request of your Executive Committee, the Sections and Membership Committee wrote to a number of sections that had general geographical names, requesting that consideration be given to changing section names to a local region in which they operate. As the result of this request, the following sections have changed their name during the past year: Gulf Coast to Sabine-Neches; South Michigan to Kalamazoo Valley; Ontario to Toronto; and Tennessee to Northeast Tennessee.

The appointment of Mr. J. H. Cottrell as Assistant Chairman of this committee was made during the year and "Cotty" has been most active in this work along with Miff.

C-2 Employment Committee

Functions of this committee are best carried through our National Office and our Society Manager, Mr. Percy V. Jones, Jr., serves as Chairman of this committee.

In times such as this when relatively full employment is enjoyed, there are fewer calls for the services of this committee. Any member of ISA or any employer is free to use the services of the Employment Committee without charge. Each section is invited to have a representative of that section serve on this committee.

A review of the Employment Committee files shows that positions listed in the Employment Section of the Journal average more than 150 annually, while replies average 1.5 per position. The above commercial listings are supplemented by listings of opens Government positions which exceed 100 annually. We have no record of replies to Government listings, since applicants write directly to the Government Services concerned rather than to a "blind box number" as in the case of the commercial positions.

The file of applicants for positions maintained at the National Office contains very few names at present due to present conditions of high employment. In certain cases where ISA members have sought positions in other localities, the National Employment Office has been helpful in placing these men in the desired location through the fine cooperation of the Employment Committee members in the various sections.

C-3 Inter-Society Relations Committee

Mr. J. C. Peters has recently been appointed as a new Chairman of this committee. He is now organizing his plans for operation and will shortly be circulating each section to determine the extent of joint activities of various sections with other societies both through the sections and nationally to our mutual advantage. Mr. Peters will welcome comments and recommendations from the sections as to desired activities in this field.

C-4 Public Relations Committee

Mr. Douglas M. Considine served as Chairman of this committee for the first portion of the year and under his direction the booklet "You and the ISA" was published. The pressure of Mr. Considine's duties as editor-in-chief of a new "Instruments Handbook", soon to be published by the McGraw-Hill Publishing Company forced him to resign his Chairmanship of this committee and Mr. C. W. (Jack) Eigenbrot of the Philadelphia Section then accepted this Chairmanship. The booklet "You and the ISA" has proven so popular that a second printing was made during this past year and this has been a material aid in the solicitation and building of membership.

Mr. Considine had started during his tenure of office work on the corporate brochure entitled "Your Company and the ISA". This work has been continued by Mr. Eigenbrot and this booklet has just been received from the press. A Corporate Membership Committee will now be formed to actively solicit Corporate Memberships with the use of this booklet.

It is the function of this committee to advertise and promote the ISA with prospective members, industries and the public. These several promotion pieces have been a tremendous aid in building the membership over the past year. This committee has a number of plans for publicity and promotion, working with our Exhibit Manager for promoting the ISA in its first big International Instrument Conference to be held in Philadelphia in 1954. Its Chairman, Jack Eigenbrot, will welcome offers of interested members to serve on this active committee.

C-5 Government Relations Committee

This committee functions to give us any necessary contacts with Government agencies. This committee is a "stand-by" and is subject to call whenever necessary to represent the interest of the society with various branches of the Government.

C-6 Educational Committee

This committee in its present composition really started moving this year. A number of meetings of the Educational Committee were held at the last annual conference in Cleveland.

The major activity of the committee during this past year was sponsored by its Chairman, Professor Jeffries, who initiated an Instrumentation Conference that was held at the Kellogg Center for Continuing Education at Michigan State College, East Lansing, Michigan on March 19 and 20. This was a conference of industry, Government and collegiate interests. Approximately 200 educators, industrialists and Governmental representatives from approximately 60 colleges, 115 industries and 15 Government Agencies attended. The proceedings of this conference are now being published and will be available for distribution at cost by the time of this meeting. The object of the conference was to stimulate interest and to foster the exchange of ideas and experiences in the field of instrumentation at the collegiate level.

As a result of this conference, there have been held in conjunction with other societies, many sessions devoted to the subject of instrumentation in various traditional areas of engineering. For example, Instrumentation in Chemical Engineering at the Indiana-Illinois Section of the A.S.E.E. Annual Meeting, numerous sessions at the National Meeting of the A.S.E.E. and a recent proposal from the University of Wisconsin to hold an institute in Industrial Instrumentation in the Spring of 1954. The University of Michigan recently scheduled a two week course in Principals in Automatic Control in Industrial Instrumentation. The University of Florida is sponsoring a Southeastern Symposium on Industrial Instrumentation on February 1 to 3, 1954 and papers are invited.

Several divisions have been set up within this committee to deal with vocational education and with special projects. The Instrument Maintenance Clinic and the Analytical Instrument Clinic are working through this committee to give these clinics the desired continuity. The committee is working on ways of taking advantage of the Educational Programs of the individual sections as they now exist in a sense of gathering information as to their reception, effectiveness and general experience so as to produce a guide for local sections on which they may draw for suggestions and ideas for local Educational Programs. They are considering the status of In-Plant Training Programs in the general field of instrumentation.

The committee has for its future program a solidification of the relationship and mode of operation with respect to the National Maintenance and Analysis Clinics; the compilation and preparation of comprehensive re-

ports covering instrumentation education in the colleges at this time.

It is apparent from the program and the work already being done that this committee is now a most active one and that much can be expected from it in the future of its work in the society.

C-7 Historical Committee

The Historical Committee is charged with keeping an adequate history of the development and growth of the ISA. This committee is in the course of reorganization and it is anticipated that a Chairman and a committee will be formed at this conference.

General Report

During the past year it has been proposed that we permit sections to be formed in Mexico under a domestic classification so that Mexico will enjoy the same privileges of membership as now enjoyed in Canada. Since postage rates and mailing costs are the same to Mexico as to United States and Canada, this change in our By-Laws is being recommended for the Council Meeting in September.

We are now ready to proceed actively with solicitation of Corporate Memberships. There is being recommended for adoption at this Council Meeting a change in the By-Laws to automatically grand Corporate Membership to all exhibitors for the year in which they exhibit. A study of our financial picture shows that exhibitors are now contributing very materially to the progress and the well being of the Society through their show participation. It was felt that it would not be in the best interests of the society to permit exhibitors to be in the position of being asked to further contribute through Corporate Membership. They are actually already serving the society as Corporate Members, so that their participation as exhibitors will automatically grant them Corporate Membership. Other instrument manufacturers and users will be solicited for such membership, all memberships to start on October 1 of each year and be charged $250 per year. The brochure "Your Company and the ISA", now available, is designed to assist in the promotion of this form of membership and copies are available on request.

At the request of our President, Mr. Porter Hart, a survey of all sections was conducted during the year exploring the degree of satisfaction of the local sections on the coordination of their activities with the National Office. The results of this survey were reported to all sections April 28. It appears that the practice of the Executive Board in sending copies of its Minutes has aided considerably in keeping local sections informed of the National activities. Correspondence with the National Office and the National Officers was found to be quite satisfactory. The principal fact developed by this survey was the definite need for a more satisfactory method of handling membership processing for new memberships and also for renewals, as well as listing the subscriptions to "Instruments" magazine. As a result, there was recommended to the Executive Board, and the Executive Board proceeded with the purchase of the necessary Address-O-Graph equipment to maintain its own mailing list and systems for processing memberships and it is fully expected that this will minimize the delays and the difficulties that have been experienced in the past.

The question of possible advantages in Incorporation of the Local Sections as non-profit corporations was raised during the year. On the instruction of the Board, we initiated a survey of all local sections to determine the extent of interest in the possibilities of incorporation. We received 31 returns from the survey at the time of this report. Two sections reported positive action on this; the Washington Section advising that it was incorporated in 1943 and the California Section advising that it is now in the process of incorporation. Over half of the remaining sections reporting on the survey evidenced interest in the subject, many stating that the subject had never been discussed before in the local section but they were interested in the possible advantages and problems of incorporation. The fact that the National Society is incorporated has no effect on the local activities of the local section. One section reported that it was now being discussed in connection with possible establishment of a Scholarship Fund. The society has now retained legal counsel, the firm of Shrum, Harrison & Craig, Law and Finance Building, Pittsburgh 19, Pennsylvania. On our request to them on their opinion, they replied as follows:

"In accordance with your recent request, we have given consideration to the various advantages which would result from the incorporation of the respective sections of the ISA.

"Among the principal advantages obtainable by operating under the corporate form are the limitation of or exemption from individual member liability for debts or obligations of the section as a whole. At the present time, each member of the section is personally responsible for any obligations incurred by the Section, to the extent to which the officers of the section are authorized by the members to incur such obligation.

"An important advantage gained by incorporation is continuity of existence, the creation of an entity endowed with capacity to exist either perpetually or for a fixed period of time, notwithstanding the death or change of its members. As a corporation, a section would have capacity to act as a legal unit, to hold property, to contract, to sue and be sued as a distinct entity.

"It should be noted that an unincorporated association is not generally recognized in American law as a legal entity having separate capacity and rights, but is regarded for most purposes as an aggregation of individuals operating as co-owners of the association with individual rights and duties. Under these circumstances, the separate identities of the members are emphasized, while the association as a whole lacks recognition as a separate and distinct unit.

"In all probability, each section would be able to achieve a greater degree of centralized management and administration than would be the case if it continued to exist as an unincorporated association.

"It is our opinion that the best advantage of the local sections would be served by incorporation for the reasons enumerated above."

At the last meeting of the Executive Board in June, the Board reaffirmed the right of each section to incorporate if the articles of incorporation are not inconsistent with the ISA Constitution and By-Laws. This material on possible incorporation of local sections is given for information purposes only with no recommendation by the Executive Board that the local section either incorporate or not incorporate. This is entirely a matter for individual determination by the local section.

Respectfully submitted,
Robert T. Sheen,
Vice President,
General Relations Division

SECRETARY'S REPORT

When the Instrument Society was first organized, Dick Rimbach served as Secretary, Publisher, and Exhibit Manager. This concentration of activities logically resulted in a change in the duties and title of the post and he was officially designated as Executive Secretary after the first few years. When the Society arranged for the employment of a full-time Society Manager, the position of Secretary was again created, and in order to have the terms of office of the Secretary not run concurrently with that of the Treasurer, it was necessary to fill the position for a one-year term in 1953. This is therefore my first, last, and only report as Secretary to an annual meeting, although I have attended most of the meetings for the last ten years.

W. A. WILDHACK

The Secretary's duties are specified in the By-Laws, Article 8, Section 3: "The Secretary shall act as recording secretary of the Society. He shall act as Secretary at all meetings of the Council and of the Society and shall perform such other duties as shall be delegated to him by the Council". Because of the rapid and continued growth of ISA in membership, and the parallel growth in ISA activities, these duties seem to give the Secretary a reasonably busy time in keeping the records straight. Fortunately, the Society Manager and the Headquarters office take

care of many details, in an efficient and expeditious manner. Mr. Jones and his staff are to be commended for their increasing effectiveness in keeping up with their assigned duties and in helping officers and committee chairmen to carry out their responsibilities.

Conduct of Society Affairs

From my short experience in this office I can see that many things can be done much better than I have managed to do them thus far in spite of the best efforts, good intentions, and cooperation from all concerned. With the help of the National Office and the Executive Board, the Secretary needs to plan for better exchange of information among officers, between committee chairmen, and between the Executive Board and the Council Delegates, and of course between the Society and its members in general. This is perhaps a platitude since all organizations, however old and well-established, always fall short of perfection in the important task of keeping everybody up-to-date. However, the rapid growth and changing structure of our Society makes the problem not only a *little* more difficult but *much* more important. I would like to record some random suggestions along these lines, not entirely as accomplishments to which we can point with pride but as desirable goals toward which we should continue to work.

1. With clerical services available at the National Office, more use should be made of the services of the Headquarters staff in duplicating letters and sending copies to all interested parties.
2. Board meetings should probably be reported in somewhat more detail than the formal minutes provide. Possibly the Secretary and President could jointly prepare an informal newsletter type of report to the Council Delegates periodically, or after each meeting of the Executive Board; or perhaps the minutes should contain more summaries of discussions.
3. Although the inevitable passage of time often frustrates our best efforts, we must continue to try to plan the agenda for each meeting well in advance.
4. Each item on the agenda which requires action should have a statement of the action proposed or the motion to be presented, preferably with an explanation giving the background, so that Executive Board members or Council Delegates can form a considered opinion in advance of the meeting. If the person requesting an agenda item would take the responsibility of doing this, the Secretary's life would be easier and the conduct of Society meetings would be more efficient.
5. In spite of best intentions and best efforts there always seems to be more business to be transacted at every meeting than the time will fit. Great commendation is due President Hart for his insistence that adequate time be scheduled for meetings of the Executive Board during the year. This has made possible unhurried consideration of knotty problems and has resulted in an amazingly large number of actions without dissent. The Executive Board has met four times since the last meeting of the Council, once for a two-day meeting. Members of the Council will recall that the Council meeting itself is wisely scheduled for the evening so that there will be ample time for the business at hand with no deadline for adjournment. Many times it is necessary or desirable for the Board or an officer to take action without the delay incident to waiting for Council meetings or even for Executive Board meetings, but in most cases actions affecting basic policy need not and should not be taken hastily.
6. In many instances, when approval of action is necessary or concurrence is desirable, a mail ballot is convenient, rapid, and effective. The Executive Board has made good use of this procedure, even on questions where a flat "Yes" or "No" is inadequate. Just a sentence or two qualifying the vote, written on an air mail postal card is valuable in giving the "sense" of the Board. I recommend to the Council and to the Board that more use be made of this method of clearing the decks.

Problems of Growth

There are a number of important problems which occupied the concentrated attention of the Executive Board during the year. Many of them will continue to raise problems for the Board and for the Council on changes of policy and procedure during the next year. Some of these are:

(1) Publications policies.
(2) Possible change in headquarters location.
(3) Degree of activity in encouraging local or regional exhibits.
(4) Methods and degrees of cooperation with other technical societies, trade associations, and other groups.
(5) The educational program of the Society; its scope and emphasis.
(6) Corporate memberships.
(7) Types of activities appropriate for Society support.

Society Handbook

It appears to be administratively essential that a complete and authoritative handbook of Society structure and procedures be compiled and maintained. It was the intention that each committee should periodically review, expand, amplify, and where necessary, revise, the definitions of their duties and procedures and submit them for Executive Board or Council approval. Unfortunately, not all committees have given this job the critical thought it deserves. The Technical Division committees have usually limited their activities to processing papers for the annual Conference; it is likely that they will expand this function in soliciting and reviewing more papers for publication, and will consider other ways to encourage education (of students, of industry and the public), to promote research; or to encourage preparation of needed books, and will generally increase their spheres of activities. All committees are urged to *review* their operations, *renew* their plans, and *rewrite* their handbooks!

Another point in connection with Committees: Section Delegates should be requested to recommend members for national committee service, supplying enough information to ensure that appointments can make the best use of the individual's talents and interest. Copies of the complete list of such suggestions should be circulated to all officers and committee chairmen.

Guidance for Executive Board

The Executive Board has need also for a revised "handbook," spelling out more clearly its duties, responsibilities, and limits of authority. When the Council directs the Executive Board to carry out a policy, or approves a Board recommendation for a policy or action, a grant of authority adequate to carry out the decision is thereby implied. However, "implied" powers are bound to be subject to varying interpretations. Uncertainty may result in failure to act, when action is needed, or in action in excess of authorization. Recognizing that perfection will never be gained by paper work, it is none-the-less essential that the Board keep clear its channels to the Council. This may be done by providing more complete and rapid information to Council members on plans or actions; by using mail-ballot requests for formal approval of Council Members; and by preparing a more explicit statement of delegated powers.

The foregoing observations and suggestions are recorded here only as friendly reminders to the Secretary and the Board and the Council for 1954.

Your Secretary would like again to report that the officers and committee chairmen and staff of the National organization are working together harmoniously and effectively to formulate and carry out a program of activities by which the Society can continue to advance the art and science of instrumentation.

There are now more than 60 sections of the Society with about 7,000 members, and more than 30 National committees. Altogether there are certainly more than 1,000 individuals serving on local or National committees. It is indeed inspiring to realize that so many men of outstanding competence are so wholeheartedly convinced of the value of the Society, to themselves, to their industries, and to the country, that they are willing to devote their time and talents to the ideals and objectives of the Society without thought of material reward.

Respectfully submitted,
W. A. Wildhack, Secretary, 1953

The Mercury Jet Switch and its Applications *

By RODNEY HOFF*

Abstract. A new-type, high-speed, multipoint selector switch for electrical contact action, termed a mercury jet switch, is described. Also, in some detail, a typical application of a series of these switches in a temperature mapping and monitoring system is included wherein 49 temperatures are repeatedly monitored every 1/10 of a second. Other possible uses for the device are visualized in the process and aircraft industries.

THE mercury jet switch is a high-speed, electrical, multiple-point selector switch which has very low switching transients. It was developed to afford rapid scanning, monitoring, and displaying of a large number of electrical signals. Instrumentation which it permits should be very useful to many phases of the chemical, petroleum, and aircraft industries.

The mercury jet switch is considerably faster than switches of comparable noise level that were revealed by a search of the literature. A jet switch, for example, has been operated at rates up to 1800 points per second with a noise level of 20 microvolts across 200 ohms. The fastest switch described in the available literature was a 45 points per second switch reported by Champion and Brokaw.[1]

This switch was used for multiple temperature recording in an investigation of steel quenching. Noise must have been somewhat less than 500 microvolts in order to obtain the reported 35° F accuracy with Chromel-Alumel** thermocouples in the temperature range being measured. Their switch consisted of a Bakelite commutator with two sets of slip rings and contact buttons. A rotating arm carried spring-loaded brushes which connected between the stationary buttons and the slip rings.

Watson and Dixon[2] reported switching four Chromel-Alumel thermocouples per second with an accuracy of 1.5°C; hence, noise must have been less than 50 microvolts. Their switch consisted of a 25-point Uniselector rotary step switch and was used for recording mould wall temperatures in the steel industry. This switch provided a period of rest after each switching operation during which switching transients could die out.

Operation of the Mercury Jet Switch

The mercury jet switch consists of a Bakelite commutator having a circular arrangement of contact pins about a rotor. A fine jet of mercury is emitted from this rotor to scan each contact in sequence as the rotor revolves. Mercury wetted contacts are used so that switching takes place between liquid mercury surfaces. This identity of contact surfaces and the absence of rubbing mechanical friction combine to virtually eliminate switching transients.

A diagram of the mercury jet switch is shown in Fig. 1. The jet is mounted on the upper edge of an inverted cone whose apex is submerged in a pool of mercury. Inside this cone is an inclined passageway through which mercury

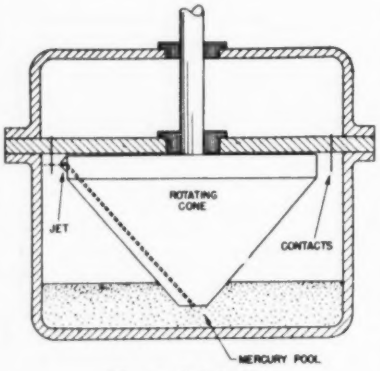

Fig. 1—Jet Switch

rises by centrifugal force to the jet when the cone is revolved. This pump-action is self-priming if the level of mercury in the pool is sufficient to raise the mercury in the passageway the first quarter of an inch. Mercury emitted from the jet comes out as a continuous stream and serves to complete the electrical path between the contact pin being hit and the mercury pool below. The action is somewhat similar to that of a hose playing on a picket fence. Expelled mercury drops back into the pool to complete the mercury cycle.

Switches built to date have 60 contacts arranged in a 4-inch diameter circle. Contacts for low voltage switching are made of 30-mil platinum wire. Platinum was chosen because it is the most insoluble in mercury of those metals which are easily wetted by mercury. For switching voltages larger than 0.1 volt, 20-mil steel music wire contacts are used because they are stronger and much less expensive. A 10-mil diameter jet size is used because it provides a continuous stream of mercury which breaks up into a discontinuous stream of droplets upon hitting a contact.

In this way, only the contact being hit is electrically connected to the pool. The 4-inch diameter was chosen as the minimum diameter in which 60 contacts can be arranged without the contacts being shorted together by mercury droplets adhering to the Bakelite and the contacts. With this spacing arrangement, the closed-circuit to open-circuit interval is about equal. During the open-circuit interval, the jet of mercury strikes a metal backplate which extends down into the mercury pool.

Baffle plates in the pool prevent excessive swirling of the mercury due to rapid turning of the rotor. Switches are operated in an atmosphere of air but are hermetically sealed to prevent continued oxidation of the mercury. Noise pick-up is reduced by mounting the switch in a grounded iron case and by shielding the mercury and the rotor from static charges on the plastic insulation as much as possible.

Application to Temperature Mapping And Monitoring

Fig. 2 is a schematic diagram of a mercury jet switch application built to map and monitor 49 thermocouples 10 times per second. In the upper right portion of this diagram is a temperature map wherein thermocouple temperatures are displayed as spots on a cathode ray oscilloscope screen. Spot size and brightness indicate temperature while spot location in the display corresponds to the location of the thermocouples. The left column of spots in

*General Electric Co., Richland, Wash.
**Trademark Registered Hoskins Corp.
*Presented at the Seventh National Instrument Conference of the Instrument Society of America, Cleveland, Ohio, September 8-12, 1952.

[1] A. R. Champion and G. K. Brokaw, "Temperature, Its Measurement and Control in Science and Industry." **American Intsitute of Physics**, Rheinhold Pub. Co. 1947, pp. 624-628.

[2] J. D. Watson and H. E. Dixon, "A Six Point, High Speed, Thermocouple Temperature Recording Equipment." **Journal of Scientific Instruments**, Vol. 26, No. 1, January 1949, p. 17.

the display is produced by known temperatures and serves as a comparison reference for estimating map temperatures.

Temperature signals used to control the brightness of the spots are obtained from thermocouples in the upper left of Fig. 2. Only two of the 49 thermocouples are shown. These thermocouples are copper-constantan and are located in stainless steel wells. For maximum heat transfer, each thermocouple is bonded directly to the tip of its well which in turn connects to building ground at various locations.

Resistance - capacitance filters are placed across the leads from each thermocouple to reduce noise pick-up and to store the signal on a capacitor so that a momentary pulse of relatively heavy current can be drawn which is independent of lead resistance. The thermocouple charging each capacitor has its hot junction located at a point whose temperature is being measured and has its cold junction at the filter terminals. Each filter consists of a 200-ohm, ½-watt, carbon resistor and a 500-microfarad, 6-volt, electrolytic capacitor. These filters are mounted in a temperature equalized cabinet to eliminate any thermocouple effects of the dissimilar metals in the filter.

Use of Pulse Transformer And Amplifier

Synchronized jet switches *1* and *3* are used to compare in sequence the voltage on each capacitor with the voltage developed by a copper-constantan junction at a reference cold temperature. As each voltage is compared, the difference is applied across the input terminals of pulse transformer 1.

Since the switches are non-shorting, each pulse is separated by a return to the no-voltage base line. The signal thus consists of a series of d-c rectangular wave pulses whose amplitudes are proportional to the temperatures being scanned. Both leads have to be switched because the grounded hot junctions would permit slight differences of ground potential to effect the signal if a second point were also common to the circuits.

The need for having both signal leads away from ground made it necessary to use a transformer. Since a transformer will not transmit d-c, the use of a transformer modified the shape of the waves from rectangles to waves with sloping tops and a variable base line. This transformer has a frequency response of 50 to 10,000 cps and a voltage gain of about 4. A 100-ohm, ½ - watt, carbon resistor is placed across the input terminals of this transformer to reduce switching noise to about 10 microvolts.

In the voltage amplifier, these signal voltages are amplified about 2,000 times. This amplifier is a conventional R-C coupled audio-frequency amplifier stabilized by negative feed-back. After amplification, these pulses are differentiated to convert them from distorted rectangular waves to sharp pulses whose amplitudes above a base voltage are proportional to the temperatures being scanned.

The Temperature Map

In the temperature display circuit, pulses are converted from signals which are proportional to temperature to signals which produce recognizable differences of dot size and brightness on the oscilloscope screen. Experiments showed that the human eye could distinguish only about seven dot sizes and brightnesses. To fully utilize these spots, it is necessary to match linear signals and non-linear screen characteristics to the logarithmic response of the human eye.

Matching is achieved by using a series of vacuum tube multivibrator circuits, which are biased to trigger progressively according to the amplitude of a pulse. Their outputs are connected so that the signal from the highest multivibrator triggered would block the output pulses from all multivibrators biased to trigger at lower voltages. Each multivibrator output is then attenuated to give discernible differences of spot size and brightness when used to control the beam intensity in the cathode ray oscilloscope.

This beam is deflected horizontally and vertically by sweep voltages obtained from jet switches *5* and *6* so that the position of the spot being formed on the screen corresponds to the thermocouple being scanned at that instant. The temperature map results when all 49 measuring spots and seven calibration spots are displayed in rapid sequence. In this map, accumulated circuit noise limits the sensitivity to about +0.5°C. The seven dot sizes and brightnesses which can be recognized limit the accuracy to about 1/7 the temperature range being viewed.

Although not tried, the use of different dot shapes was considered—such as vertical lines, horizontal lines, and inclined lines, in addition to size and brightness to increase resolution of the temperature range. Perhaps even differences of color could be used. These different shapes or colors could be formed by deflecting the beam a small amount with signal voltages from the individual multivibrators.

When viewed under normal room lighting at 10 scannings per second, flicker is quite noticeable even though a long persistence P7 screen with a Wratten No. 15 light filter is used. Flicker is observed to increase with increased beam intensity and with decreased scanning rate; hence, flicker could be reduced by using one of the newer dark screened tubes which give greater contrast at lower intensities, by viewing in a darkened room, or by a faster scanning.

Temperature Deviation Map

Just below the temperature map in Fig. 2 is shown a temperature deviation map. This map is formed by combining the sweep voltage signals with an intensity control signal which varies in proportion to the temperature difference of each thermocouple from a value set for each thermocouple. Temperatures above their set values are indicated by spots brighter than those for no difference while temperatures below their set values are indicated by spots which are not as bright as those for no difference.

Deviation signals are obtained by comparing the voltage of each pulse being scanned with a bucking voltage set for that particular point. The switching action involved jet switches *2*, *3*, and *4*. Jet switches *2* and *3* select the thermocouple voltage to be measured, while jet switch *4* selects the bucking voltage against which this thermocouple voltage is compared.

If the thermocouple voltage is larger, a pulse is developed in transformer *2* proportional to the direction and magnitude of the difference. This pulse is amplified and then used to control brilliance of the spot being scanned so that its brightness increases above that corresponding to no change. A decrease below the set value lowers the brightness below that for no change.

Temperature and temperature deviation pulses are monitored by means of the *annunciator* shown in Fig. 2. This annunciator detects any pulse whose value exceeds limits set for excessive temperature, excessive temperature increase, or an excessive temperature decrease. If any of these conditions exists, an alarm light comes on to indicate that a limit is exceeded while a second light comes on to indicate which of the three limits had been exceeded.

At the same time, a pulse is sent through jet switches *7* and *8* to the *row* and *column* locators which light neon bulbs to indicate which thermocouple exceeds the limits. All these monitor indications persist until manually reset. The monitor is thus capable of detecting the presence of an abnormal temperature condition, of indicating what the condition is, and of telling which thermocouple has this condition, all within 1/10 of a second.

Other Possible Applications

Beside thermocouple switching, the mercury jet switch should be useful for scanning various other electrical signals—such as those from strain gages, transducers, and temperature reisistance elements. Pressurized, the mercury jet switch should be useful for high voltage commutation and switching.

Instrumentation in which this switch might be applied includes pressure, strain, flow, or power mapping and monitoring. It may be possible to display and monitor the indicated signals from hundreds or even thousands of other instruments scattered about a plant. In one glance it would then be possible to see what is going on at the moment or to see if there are any variations from a set pattern of what

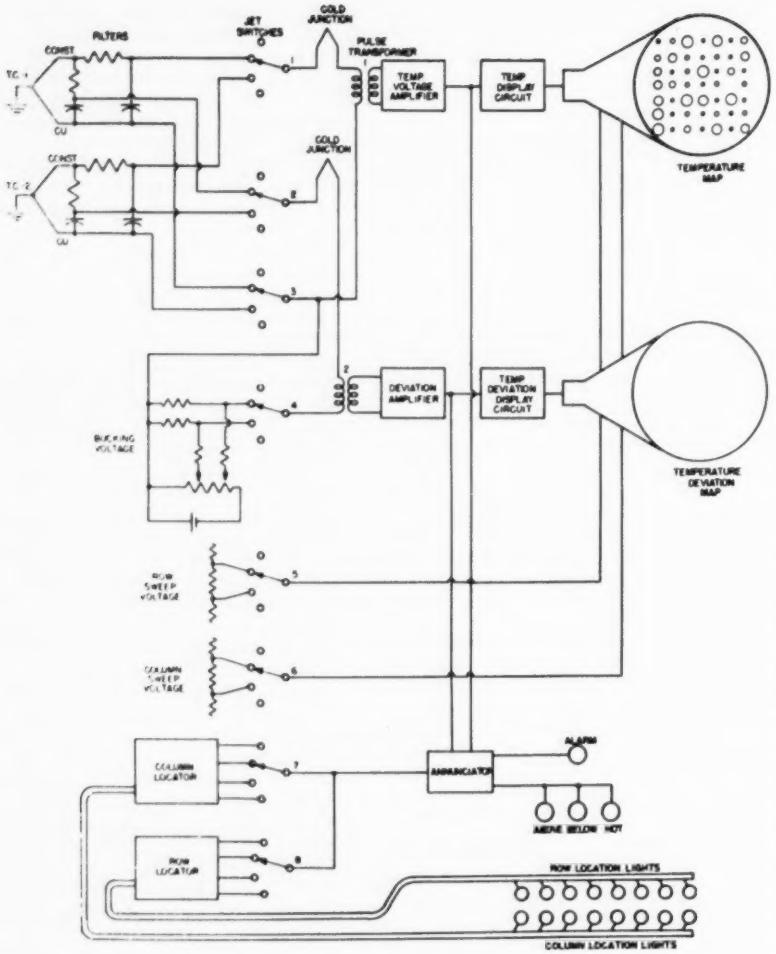

Fig. 2—Temperature Mapping System

the instruments are supposed to read. This instrumentation should find wide application in the chemical industries, in controlling power reactors, airplanes, guided missiles and in various transient studies.

Conclusion

The mercury jet switch and its equipment for application to a temperature mapping system as described above have been built and tested. The jet switches have been operated for several thousand hours without any apparent wear or abrasion of the contacts. Hence, it is felt that the feasibility of using a rotating jet of mercury as the selector contact in an electrical switch has been demonstrated. The switch described herein, or various modifications of it, should find many applications wherever rapid scanning of multiple leads is necessary.

The temperature mapping system described above is an application which has been accomplished on a small scale model of a much larger system which is being considered. This small scale model permitted 49 temperatures to be repeatedly monitored every 1/10 of a second. Visual displays of the temperature pattern and the temperature deviations from a set temperature pattern were each displayed on a cathode ray oscilloscope screen. These temperatures and temperature deviations were repeatedly monitored so as to automatically detect whenever a limit had been exceeded, which limit, and at which point, all within 1/10 of a second. Various modifications of this system would permit this system to be used for displaying and monitoring conditions occuring at a large number of points.

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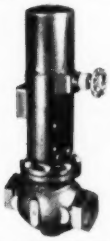

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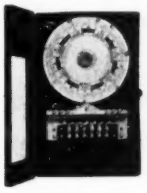

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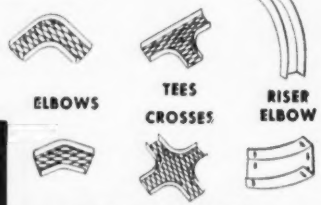

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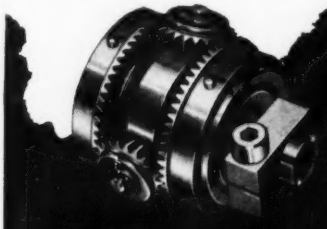

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Fig. 1. Flexflo assembly.

EXPANSIBLE-TUBE VALVES

Expansible-tube-type valves have been used for years in many industries. They differ radically in design from conventional regulator valves, and present intriguing possibilities for the gas-distribution industry.

By FOREST H. WEHRMAN
Grove Regulator Co.

GROVE expansible-tube-type valves were introduced about 12 years ago and are widely known by the trade name "Flexflo." Changes have been made in body design, core design and material, tube design and tube molding technique, and design pilots, all to better adapt the Flexflo to the gas industry.

The Flexflo valve is a simple and rugged unit with few components and only a single moving part. Fig. 1 shows a disassembled Flexflo valve, showing its components. The moving part is the expansible tube which acts as both valve and operating diaphragm. The tube is made of Hycar synthetic rubber, especially compounded to insure the necessary strength, flexibility, tear resistance, and resistance to abrasion. Fig. 2 shows the principal features.

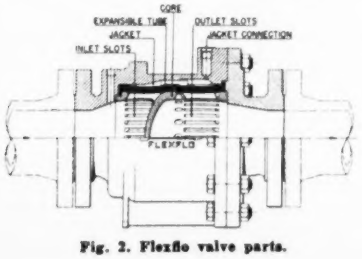

Fig. 2. Flexflo valve parts.

Oeration Principle

The Flexflo is open, closed, or throttling, depending on the position of the tube on or above the slots in the outlet end of the core. This position depends on the relative magnitude of the pressures in the valve inlet, outlet, and jacket.

The initial tension of the tube over the core also affects the operation because this tension produces a pressure (called the expanding pressure) which is at all times additive to the pressure in the jacket. The sum of the jacket pressure and the expanding pressure is termed the *effective jacket pressure.*

Fig. 3 shows sections of the Flexflo valve in the closed, throttling, and wide-open position. To close the Flexflo it is necessary only to introduce the full inlet pressure into the jacket. This makes the effective jacket pressure greater than the line pressure and thus forces the tube against the core slots to close the valve.

By releasing pressure from the jacket until the effective jacket pressure is less than the downstream line pressure, the tube will be made to rise completely off the core to open the valve to its fullest extent.

The Flexflo will throttle if the effective jacket pressure is less than the upstream pressure but greater than the downstream pressure. Under these conditions the tube is completely off the inlet core slots but only partially off the outlet core slots. The jacket pressure necessary for throttling can be produced by manual or automatic pilot control.

The heart of the Flexflo regulator is the expansible tube, which is made of a special Hycar compound for all standard applications. The material for the tube must have high strength, tear, and abrasion resistance. It must be resistant to hydrocarbons and not swell appreciably in normal service. It must have a low permanent set under prolonged tension so as not to lose its initial stretch on the core.

Applications

The Flexflo is suited for manual open-shut flow control, pressure-reducing and back-pressure regulation, pressure re-

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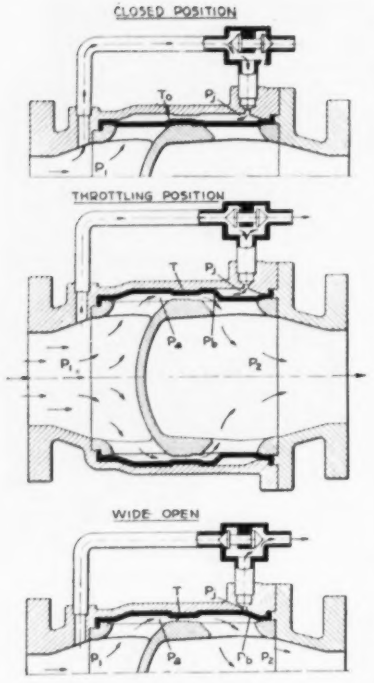

Fig. 3. Flexflo operation.

lief, flow-rate control, liquid-level control, line overpressure and underpressure, pump control, and a variety of other uses. Grove-designed pilots are available for all of these services to provide stable and accurate control. In nearly every case the operating force is derived directly from the line. The controlling force for the pilots may be derived from the line, from independent sources, or from instruments. The Flexflo is limited to a fluid temperature range of 0 to 150 deg. F.

For stable automatic throttling control it is recommended that the pressure drop across the Flexflo be at least twice the tube expanding pressure. A table of expanding pressures is given below for a few Flexflo sizes.

The Flexflo is manufactured in 1-inch through 12-inch sizes in four basic pressure ranges as follows: (1) low pressure—200 or 230 psi. maximum CWP., (2) medium pressure—400 or 600 psi. maximum CWP., (3) high pressure—1200 psi. maximum CWP., and (4) extra high pressure steel—1440 or 1500 psi. maximum CWP.

The minimum operating pressure drop through a Flexflo regulator is normally taken as double the tube expanding pressure. This gives about 10 psi. as the minimum drop through a low-pressure valve of 3-in. size or larger. A larger drop is required in smaller sizes. However, with special hook-ups, Flexflo regulators may often be used at lower differentials, even differentials below the tube expanding pressure.

TABLE OF EXPANDING PRESSURE FOR STANDARD HYCAR TUBES

Flexflo Size (Inches)	*Low-Pressure Flexflos*	*Medium-Pressure Flexflos*	*High-Pressure and Extra-High-Pressure Flexflos*
1	19	.....	60
2	7½	19	30
4	5	12½	23
8	3½	9	9
12	4	10	10

REGULATORS AND PILOTS

A number of pilots and pilot systems are available for operation of the Flexflo as a reducing regulator, a back-pressure regulator, and other types of operation.

The Flexflo differs greatly in construction from the ordinary regulator valve. Its main features are its simplicity, freedom from trouble, and the ease of repair. The Flexflo closure can be unbolted, the core and tube removed, a new core and tube slipped in as a unit, the closure replaced, and the whole job is done in a few minutes in the field.

Owing to simplicity of design, the Flexflo regulator is basically cheaper than more conventional types. It is basically a diaphragm-operated valve, but doesn't require a large high-pressure diaphragm case. The valve body is the diaphragm case and thus is built right in. This advantage becomes more apparent in the larger sizes. In smaller sizes the advantage is not so apparent because the necessary pilot may in some cases cost as much or more than the Flexflo.

Pounds-to-ounces Regulator

A photograph and schematic diagram of a Flexflo Reducing Regulator, using a small reducing valve as a pilot, is shown in Fig. 4. This is a type of pilot operation which is used often with more conventional types of regulator valves. In this system, gas is bled on to the jacket space or "diaphragm" through a fixed orifice, and bled off through the pilot regulator.

This type of pilot operation with a Flexflo is particularly suited for "pounds to ounces" or "pounds to inches" pressure reduction using a standard gas-service regulator or other suitable low-pressure regulator as a pilot. However, it is also used for "pounds to pounds" pressure reduction using a suitable small reducing regulator of proper pressure range as a pilot.

Gas is taken from the inlet of the Flexflo (Fig. 4) and passes through orifice A to point X, and from there into the pilot regulator. Under throttling conditions there is a continuous flow through the pilot regulator. This flow causes a pressure drop through orifice A, making the pressure at point X (the inlet of the pilot regulator) less than the inlet line pressure to the Flexflo. Under any steady flow, the Flexflo jacket has the same pressure as point X because these pressures equalize through orifice B. If the Flexflo is not passing enough gas, the pressure falls slightly in the downstream line.

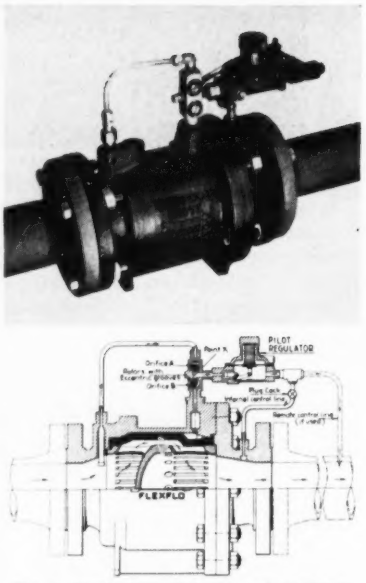

Fig. 4. Flexflo "pounds-to-ounces" regulator.

This causes the pilot regulator to open wider and pass more gas. This extra pilot flow increases the pressure drop through orifice A. This reduces the pressure at point X and, in turn, reduces the jacket pressure, causing the Flexflo to open wider to pass the required flow. Similarly, if the Flexflo is passing too much gas, the increase in pressure downstream reduces the flow through the pilot regulator which, in turn, closes the Flexflo to the proper throttling position.

In this regulating system, orifice A determines the sensitivity or accuracy of regulation. The smaller the orifice, the less flow is required through the pilot regulator to open the Flexflo, and hence the more sensitive the control.

Orifice B has no effect on the sensitivity of regulation. Under some conditions, if the regulator has a tendency to hunt or be unstable, proper adjustment of orifice B will slow down the action to stop the hunting. Under most installations in gas service, throttling of orifice B is not necessary and it should be set for maximum opening.

When a spring-loaded regulator is used as a pilot for the Flexflo, as shown in Fig. 4, a failure of the pilot diaphragm will cause the Flexflo to go wide open. This opening on failure is often a desirable characteristic in gas line installations.

"Models 820 and 830" Spring-loaded Pilots

The "Model 820" is a spring-loaded reducing regulator pilot (Fig. 5) specially designed for use with the Flexflo. It is made with a number of diaphragm and spring sizes, covering a range from 2 to 1500 psi. reduced pressure.

For ordinary reducing valve service, the principle of operation of the "Model 820" is similar to the pilot system shown in Fig. 4. However, the construction and certain features of the

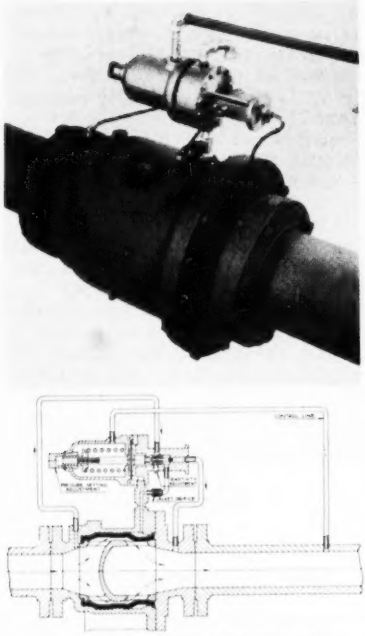

Fig. 5. Flexflo and "Model 820" pilot.

operation differ greatly from the ordinary reducing regulator used as a pilot.

The valve body of the "Model 820" has three ports which are connected respectively to the operating gas supply (inlet gas line), the Flexflo jacket, and exhaust (outlet gas line). The valve plug is a double-acting plug operating between inlet and outlet seats so as to form a 3-way throttling valve. This valve proportions the pressure drops through the inlet and outlet seats so as to supply some proportionate pressure, between inlet and outlet pressure, to the Flexflo jacket.

In the "Model 830" reducing regulator pilot, the diaphragm and spring case differ slightly in that the spring is arranged to push down instead of pull up on the diaphragm. The principle of operation of this pilot is the same as the "Model 820" except that it controls the upstream rather than the downstream pressure.

The Flexflo Booster Regulator

One of the newest developments with the expansible-tube valve is the Flexflo Booster Regulator. The Booster Regulator differs from a standard reducing regulator in that the reduced pressure rises with increased flow at a predetermined rate so as to compensate for line losses in the downstream system.

The chief application of a Booster Regulator is for supplying gas to distribution systems. Its use greatly reduces the average pressure maintained in the system and thereby reduces the amount of loss from leakage or "unaccounted for" gas. With a Booster Regulator it is possible to maintain virtually a constant pressure at the furthest point (point of lowest pressure) of the system. This type of regulation gives a lower over-all average pressure throughout the distribution system than would be obtained by a conventional type of regulator which must be set to deliver enough pressure to carry the peak loads and supplies more pressure than necessary at other times.

THE FLEXFLO AS A DIAPHRAGM MOTOR VALVE

Fig. 6 shows a Flexflo motor valve using a "Model 824 Proportional Operator." The valve body of the "Model 824" has 3 ports which are normally connected to the inlet, jacket, and outlet of the Flexflo. The valve in the "Model 824" is a 3-way valve with a double characterized plug which proportions the jacket pressure to some pressure between inlet and outlet in accordance with the valve plug position. The characterization of the pilot valve plug is such that the Flexflo opens (or closes) slowly with movement of the valve plug when the Flexflo is near closed, and then opens more and more rapidly as the Flexflo opens further.

The valve plug of the "Model 824" is operated by instrument air pressure acting on a diaphragm. Application of instrument air opens or closes the Flexflo to some opening depending on the instrument air pressure. The characterization of the "Model 824" plug gives a characteristic similar to a characterized plug in a conventional motor valve—that is, the response of the Flexflo to changes in instrument air pressure is greatest when it is the furthest open.

Self-operated Flexflo Back-pressure Regulators.

In the systems discussed so far, the Flexflo has been closed by supplying inlet line pressure to the jacket, and opened to throttling position by bleeding off the jacket a certain amount below the inlet pressure by means of a suitable pilot.

The Flexflo may be used as a back-pressure regulator without varying the jacket pressure. Suppose the jacket pressure is held constant at some value. As long as the inlet pressure is equal to or lower than this pressure, no flow occurs. However, if the inlet rises above the jacket pressure sufficiently to overcome the tube expanding pressure, the Flexflo will open to throttle. A further rise in inlet pressure will cause more flow.

One method of loading the Flexflo jacket to make a back-pressure regulator is known as the "Dome Pressure Loaded" method because the operating gas (the jacket pressure) is contained in a sealed system.

The Flexflo jacket is connected to a cylinder to give additional volume. This is to reduce to a small value the change in jacket pressure with expansion and contraction of the Flexflo tube, and also to allow the cylinder (which contains the major portion of the sealed-in gas) to be buried to eliminate the effect of temperature change.

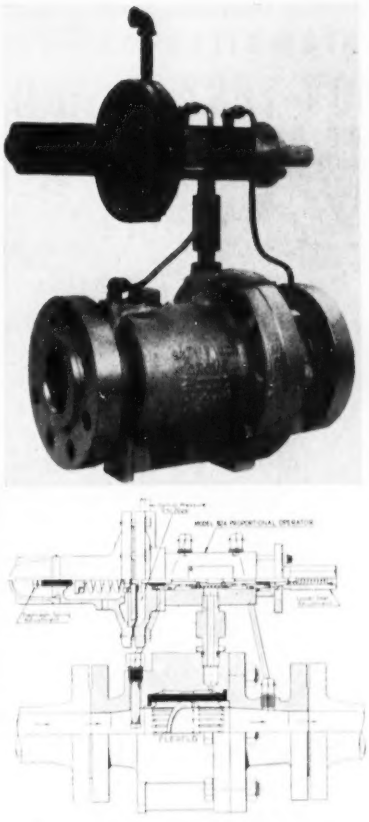

Fig. 6. Flexflo diaphragm motor valve.

As the required loading pressure in the jacket and the cylinder is less than the inlet pressure, these may be charged from the inlet gas line by means of a needle-valve system.

Stability

Self-operated Flexflo back-pressure regulators (dome loaded or pilot loaded) are extremely stable and throttle smoothly in almost any possible installation, regardless of flow rates or length of piping.

Pilot-operated Flexflo regulators, like all pilot-operated regulators, present a stability problem and must be installed properly in order to give stable operation, free from hunting. Back-pressure pilot-operated regulators present less of a problem than the reducing regulators—mainly because back-pressure regulators are much less apt to be installed under unfavorable conditions than reducing regulators.

The only requirement for stable operation of a pilot-operated Flexflo regulator on gas is that there should be sufficient length of pipe upstream and downstream from the Flexflo, between it any other regulator or other throttling valve or restriction. This volume acts as a "cushion" to permit the regulator to establish itself in the proper throttling position. For back-pressure regulators, the upstream line is more important than the downstream. As back-pressure regulators

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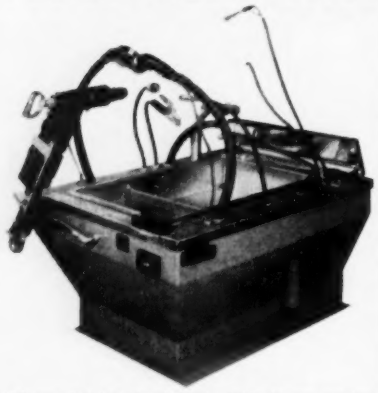

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seldom are installed where they are fed by a regulator or throttling valve close by upstream, there is seldom any problem. On the other hand, reducing regulators often are installed under unfavorable conditions, such as in two-stage reduction, etc.

If a Flexflo reducing regulator is installed in a gas main to reduce pressure to a lower-pressure gas main, or if it is used at a city gate to reduce to the city distribution system, perfectly stable operation should be obtained as long as the reduction is taken in a single stage. There is no reason for using more than one-stage reduction with the Flexflo in a gas main. Flexflo reducing regulators have been used often to replace two-stage reduction with a single-stage, with satisfactory results.

One reason for using a two-stage reduction at a city gate is for safety; if one regulator fails the other takes over and holds the downstream pressure (at a somewhat higher value if the second regulator is the one that fails). With the Flexflo regulator, this should not be necessary; if the downstream line is equipped with proper relief valves, this is all the protection necessary.

However, if it is felt that two reducing-regulators are desirable, they may be arranged as follows to give the desired protection without interfering with the regulation: Two Flexflo regulators are placed in series with the control lines of both connected into the low-pressure system below the second regulator. If the pilots are the type where the pilot discharge flows through the control line, the two control lines from the two pilots should not be interconnected but should connect to separate taps on the downstream system. One regulator (probably the downstream one, but can be either one) then is set for a slightly lower pressure than the other, and takes the whole drop and controls the pressure. The other regulator normally remains wide open, but acts as a standby to take over and control at its set pressure in event the first one fails and goes open.

This type of control with a standby series regulator also can be used with a single Flexflo and with some other type of regulator as the standby.

Determination of Capacity

In most applications, the correct regulator size is one or more sizes smaller than the line in which it is to be used. Capacities of all Grove regulators are given in "rated" capacity. This is not the wide-open capacity of the valve, but is a lesser value chosen to ensure good regulation and also to allow for some inaccuracy of determining the required capacity. The amount that the rated capacity is below the wide-open capacity depends on the type of regulator.

For Flexflo regulators, the rated capacities are chosen to ensure good regulation and also to allow for the fact that the pilot systems are often incapable, under certain pressure conditions, of opening the Flexflo completely wide open. There is, however, enough elasticity in the "rated" capacity to allow for an inaccuracy of about 10 percent in determining the required capacity.

Some manufacturers give wide-open capacities for regulators and instruct the customer to make certain allowance to ensure good regulation and to cover inaccuracies of calculation of required capacity. In Grove charts and tables giving "rated" capacity, this allowance already has been made.

The wide-open capacity of a Flexflo valve is about the same as that of a full port globe valve. The "rated" capacity of the Flexflo for use as a regulator, although considerably lower than the wide-open capacity, compares favorably with the useful capacity of more conventional regulators.

Conclusion

The Flexflo is better adapted to continuous movement than a conventional valve because there are no moving metal parts. The tube remains in good operating condition because of the "exercise" of its movement.

The Flexflo Valve is more suitable for use as an emergency valve or one that is operated only occasionally because it can be depended on to operate freely after long periods of inaction. Unlike conventional valves, which have metal parts in contact with each other and which may corrode and stick, the Flexflo's only moving part, the expansible tube, is always ready for action.

Small particles of foreign matter, which could prevent the conventional valve from seating, cause no difficulty at all with the Flexflo. The tube conforms, covers the foreign matter, and closes tightly.

Wear, erosion, and distortion caused by attempts to force or jam metal to metal valves and seats together produce ever-increasing leakage. The softness of the Flexflo tube permits it to seal tightly even after considerable cutting or erosion of the seating surface has occurred.

The action of the Flexflo valve is somewhat similar to that of a slide valve, but it differs in that the Flexflo gives tight shut off whereas this is seldom obtained with a conventional slide valve. Because of the action of the differential pressures, the Flexflo valve opens and closes smoothly, especially at the point of cracking or contacting the seat. It does not create hydraulic shock like a mechanical valve. For this reason the Flexflo valve is especially advantageous for throttling or modulating flow.

References

1. Bryant, Austin, "Burst Test Apparatus for Rubber and Synthetics," A.S.T.M. Bulletin No. 148, October, 1947.

2. Niederer, Jr., Edward, "Expansible Tube Type Regulators Suggest Possibilities in Station Design," *Gas Age*, October 25, 1951.

Corrections for the 1954 INDEX

All readers are urged to make the following corrections in their 1954 INSTRUMENTS INDEX, which was received with the August, 1953 issue of INSTRUMENTS.

The advertisement of Dragon Engineering Co., 5817 S. Central Ave., Los Angeles 11, Calif. was improperly listed in the Advertiser's Index. The advertisement appears on page 176 while the Advertiser's Index gives the page as 116. Dragon Engineering manufactures high-pressure needle valves and fittings.

Pancro Mirrors, Inc., 2958 Los Feliz Blvd., Los Angeles 39, Calif. was omitted under the listing "Mirrors" on page 110; and also do high vacuum lens coating.

Manning, Maxwell & Moore, Inc., Stratford, Conn, was listed in the Advertisers' Index as appearing on page 47, whereas they actually appear on page 41. M M & M manufacture industrial instruments, pressure gages, safety and relief valves, etc.

Gorman Mfg. Corp., 2240 Sepulveda Blvd., Los Angeles 64, Calif. should have appeared under RESISTORS, Wire Wound on page 140.

Edcliff Instruments, 383 North Foothill Blvd., Pasadena 8, Calif. should have been listed under POTENTIOMETERS, Precision Linear and Non-Linear on page 121.

PSP Engineering Company, 8420 Otis St., South Gate, Calif. should be listed under SOLENOIDS on page 146.

Arnold O. Beckman, 1020 Mission St., S. Pasadena, Calif. should be listed under the following headings:

GAS ANALYZERS, Oxygen & Nitrogen Apparatus

X-RAY MEASURING INSTRUMENTS

Rahm Instruments, Inc., 12 West Broadway, New York 7, N. Y. was improperly listed in the addresses section. The description under this company's name on page 203 should read "Potentiometer Transducers for pressure, altitude, air speed and acceleration."

John Chatillon & Sons, 85 Cliff St., New York 38, N. Y. should have been listed under the following headings:

SPRINGS for Accelerometers, Aircraft Instruments, Altimeters, Aviation Instruments, Cameras, Computing Scales, Controllers, Flow Meters, Navigational Instruments, Pressure Controllers, Pumps, Regulators, Relays, Scales, Switches, and Valves.

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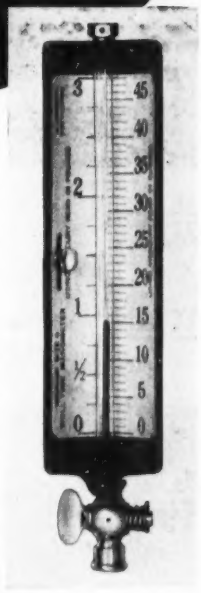

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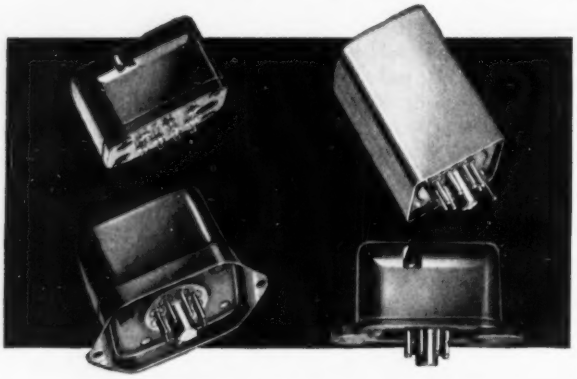

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UNITS and STANDARDS

Continued from page 1522

Standard resistors and *standard cells* to which values have been assigned by these absolute electrical measurements serve to carry forward the basic electric units from month to month and year to year. The permanence of such standards is such that they may be expected to drift only a few parts per million in 10 or 20 years. The precision with which they can be compared with other similar standards is about one part in 10 million. As a result, a situation exists which is closely analogous to that already pointed out in the case of the unit of time—that is, the unit is maintained and reproduced with high precision, but must be verified at intervals by absolute measurements, the accuracy of which is still, unfortunately, of a lower order.

From the ohm and the volt as a basis, the other electric and magnetic units—ampere, watt, henry, farad, gauss, and oersted—can be derived. By suitable comparisons of standard resistors (successively in series and in parallel) ratios of resistances can be established with an accuracy of a few parts in 10 million. Such ratios can be used to extend the range of electrical measurements to millions of volts, tens of thousands of amperes, and millions of billions of ohms.

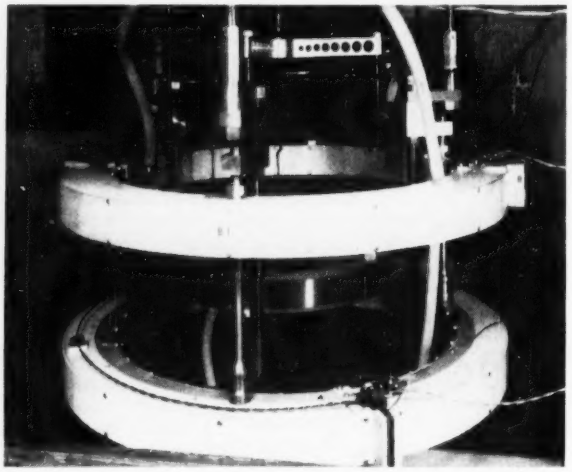

Fig. 5. Coils of NBS current balance. Single-layer movable coil wound on glass form hangs from one arm of a precision balance by which vertical force of attraction or repulsion is measured. Larger fixed coils are wound of aluminum strip and kept cool by circulation of water through hoses.

Unit of Temperature

Another fundamental measurement is the measurement of temperature. The fundamental basis for temperature measurements is the thermodynamic scale originally proposed by Lord Kelvin in 1854. This can be realized experimentally only by laborious and difficult experiments employing gas thermometers. The accuracy of realization of this scale over much of its range is probably only 0.05 deg. C.

For many industrial and scientific purposes it is important to be able to reproduce or to hold constant temperatures to considerably greater accuracy. To accomplish this, an International Temperature Scale has been developed and was adopted internationally by the General Conference on Weights and Measures in 1927. This scale was intended to be as nearly identical with the thermodynamic centigrade scale as possible. The scale was defined by six fixed points and the indications of interpolation instruments, calibrated at the fixed points according to a specified procedure. In 1948 minor revisions were made in this scale including (1) a change in the silver point from 960.5 deg. C. to 960.8 deg. C., (2) the substitution of the Planck radiation formula for the Wien formula used above the gold point, and (3) the adoption of the value 1.438 cm.-degrees for the constant c_2 in this formula. This revised scale will probably

prove satisfactory for a long time, but possible changes are already under consideration.

One impending change is the use of the *triple point* of H_2O (where water, ice, and water vapor are mutually in equilibrium) to replace the ice point (which is the temperature of equilibrium between water, ice, and air saturated with water vapor and presumably with the normal content of carbon dioxide). The triple point is taken to be +0.0100 deg. C. It is more definite and more easily reproduced than the ice point.

Another development is the use of the *Johnson noise*, which occurs in electrical circuits as a result of the Brownian motion of the electrons. As this motion is a function of the absolute temperature, it is theoretically possible by purely electronic techniques to measure absolute thermodynamic temperatures. Research along this line is now active, but the results to date are not as accurate as determinations by the gas thermometer.

Another impending fundamental change will affect the absolute thermodynamic scale. In defining a thermodynamic temperature scale it is necessary to specify not only the general scale law derived from the Second Law of Thermodynamics, but also to choose arbitrarily the size of the

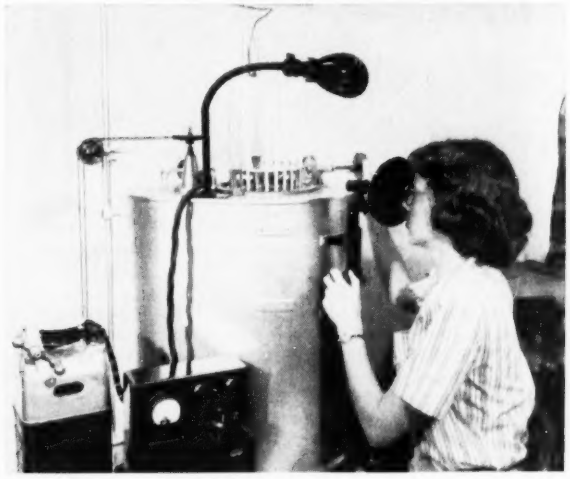

Fig. 6. Testing of liquid-in-glass thermometers at the National Bureau of Standards. The operator reads the thermometers in succession, using the telescope. The platinum resistance thermometer in center of bath indicates the true temperature.

degree. Lord Kelvin chose the size of the degree by making the interval between the ice point and the steam point exactly 100 degrees. Recent developments in physics have made measurements close to the absolute zero (−273.16 deg. C.) of great scientific importance, and it is a little illogical to specify temperatures in the liquid helium range to a precision of 0.0001 deg. when the absolute temperature based on the ice point may be in error by hundredths of a degree. A resolution adopted by the General Conference on Weights and Measures, therefore, proposes that the scale be fixed by assigning a definite value for the triple point relative to the absolute zero, and deriving the size of the degree from this. The assigned value will, of course, be chosen so as to make the new degree as closely as possible the same size as on the present Kelvin thermodynamic scale. No decision has yet been reached on what absolute temperature to assign to the triple point.

It is not paradoxical to have processes of growth and evolution bring about changes even in the most fundamental units of measurement, at the very time that every effort is continuously being made to keep these units as definite and constant as practicable. Like many living organisms, all branches of science are interrelated, and growth and activity in any part affects and is affected by developments in all other parts.

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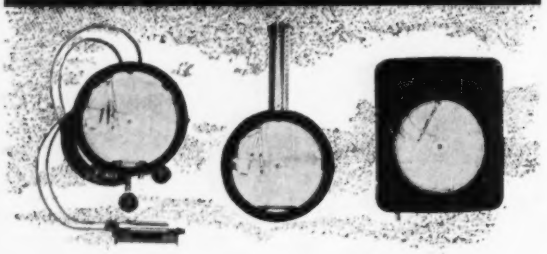

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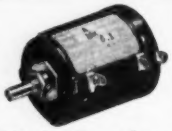

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PYROMETRY

Continued from page 1525

a platinum vs. platinum-rhodium couple inserted in the same alumina sheath. A parabolic curve was obtained which crosses the temperature axis at 1220 deg. C. This should be remembered because, although the thermocouple generates only about 3.5 millivolts at 1800 deg. C., the sensitivity is nearly 7.5 microvolts per deg. C.—that is, about half that of the platinum couple. The cold-junction correction curve also is given in Fig. 4. Owing to the inversion of the emf. at 1220 deg. C., cold-junction corrections must be subtracted from the measured emf. at temperatures above 1220.

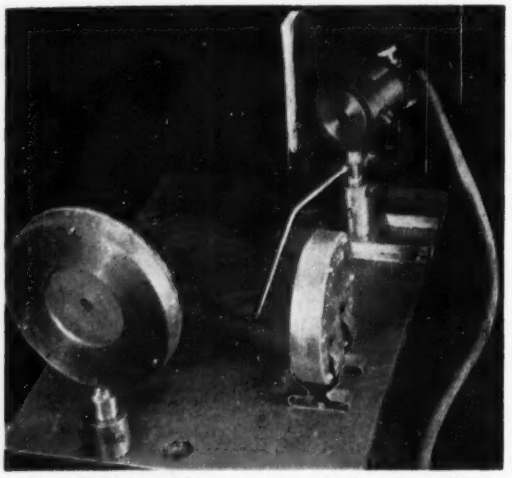

Fig 5. Fixed-focus mirror pyrometer, showing mirror, thermopile, and (to the right) silica-gel desiccant.

Calibration of the couples made from wires from five suppliers showed that consistent results were obtained from each batch. One supplier's wire gave the same calibration for three separate batches. Both annealed and unannealed couples gave the same calibration curve up to 1900 deg. C. The couples were not contaminated by contact with alumina powder but were affected by graphite, although the effect was slow enough to allow accurate immersion readings.

Steel Works Trials

Efforts were made to make the tungsten-molybdenum pyrometer similar to the platinum. It was possible[6] merely to replace the one thermocouple by the other, although the tungsten and molybdenum wires are much stiffer.

Below 1750 deg. C. the readings of the tungsten-molybdenum were compared with those of the platinum vs. platinum-rhodium pyrometer in a 4-ton electric-arc furnace and in a high-frequency furnace. In about 20 casts the temperatures agreed to within 10 deg. C. The brittleness at the hot junction of the tungsten and molybdenum wires after heating prevented a second reading being taken. Therefore, about six inches of the wire were pulled through the pyrometer and a new junction welded.

Temperatures of at least 1850 deg. C. are obtained in the electric-arc furnace after oxygen has been blown through the steel. The measurement is difficult because silica cannot be used for the protecting sheath, and no reliable substitute had been found. Alumina sheaths covered with aluminous cement have been tried.

Graphite sheaths protected with cement have enabled readings to be obtained on occasions. Care must be taken that the steel does not penetrate the cement coats because the graphite is rapidly dissolved by the decarburized steel.

FIXED-FOCUS MIRROR PYROMETERS

Steel is melted in the open-hearth furnace by a narrow jet of flame which expands to cover the bath. The distribu-

tion of radiation and temperature along the length of the flame determines the effectiveness of the heat transfer in each part of the steelmaking process. Therefore, for the flame radiation investigation[7] by the Joint International Committee on the experimental furnace at Ijmuiden, a special pyrometer has been developed[8] which accepts a narrow cone of radiation. The flame emissivity, assumed equal to its absorptivity, is determined by measuring the fraction of the radiation from the furnace wall which is absorbed by the flame; this technique is known as the

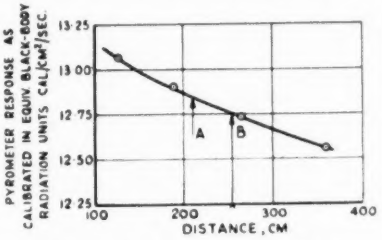

Fig. 6. Relation between pyrometer response and distance. A: Distance of middle of furnace from pyrometer mirror. B: Distance of calibrating source from pyrometer mirror.

Schmidt method of determining flame emissivity and temperature, and is discussed briefly by Comerford[9] and by Daws and Thring.[10]

Design of the Pyrometer

A front-surfaced gold mirror was used to condense the radiation onto a Moll-type thermopile. A 4.0-cm.-diam. source at 12'9" (390 cm.) from the mirror formed an image of 1.88 mm., which overlapped two elements of the thermopile. The diameter of the mirror stop was 2.16" (5.5 cm.) and, therefore, the pyrometer accepted an almost parallel beam of radiation.

The mirror and thermopile (Fig. 5) were built on a brass plate, which was bolted on to the base of a water-cooled box. The thermopile was placed a few degrees off the optical axis to shield it from direct radiation. The front aperture of the water-cooled jacket contained a thin mica screen to keep the pyrometer free from dust and contaminating gases. The mica screen was kept clean by a stream of air blown radially across it. A silica-gel cell was fixed into the pyrometer to keep the atmosphere dry. Out-of-focus radiation was prevented from reaching the receiver by a set of non-reflecting diaphragms made from copper. The diaphragms were pressed tightly into contact with the case of the thermopile.

Characteristics

A flame is a source of radiation of considerable depth and, therefore, the effect of the distance of the hot source from the pyrometer mirror was investigated. The results are presented in Fig. 6. As the source is moved from 3' 3" (100 cm.) from the mirror to 13' 1" (400 cm.) the output of the pyrometer falls by about 4.5 percent. This is due mainly to absorption by water vapor and dust in the atmosphere. The pyrometer was calibrated at the mean position of the radiating sources—that is, at position B in Fig. 6; position A indicates the distance of the middle of the Ijmuiden furnace from the mirror.

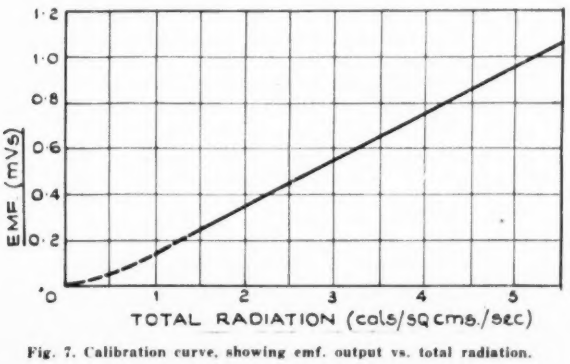

Fig. 7. Calibration curve, showing emf. output vs. total radiation.

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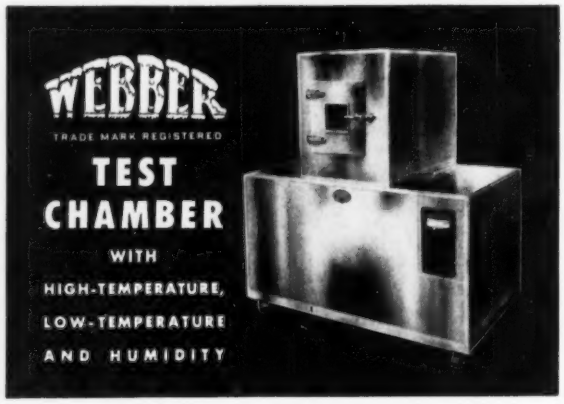

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Experiments with the pyrometer body at different temperatures showed that the calibration fell by 0.05 percent per deg. C. The pyrometer took about 5 sec. to reach 98 percent of full reading. A typical calibration curve is shown in Fig. 7. The curve remains linear for higher total radiations.

Conclusions

(1) Use of a reflector to reduce the effect of surface emissivities has been proved reliable. This device makes possible accurate surface-temperature measurement by a radiation method: use of the technique for radiation detection offers scope for many developments.

(2) The tungsten vs. molybdenum immersion pyrometer now can be used as a supplement to the platinum vs. platinum-rhodium (13%) pyrometer. Temperatures can be measured above the melting point of platinum.

(3) A pyrometer developed for the accurate measurement of flame radiation enables the emissivity and temperature of industrial-size flames to be determined.

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TRANSDUCERS

Continued from page 1527

converter, a printer, an environmental test chamber, and necessary command and control circuits.

The timing command chassis serves several purposes. Its first is to control the temperature in the environmental test chamber; any program of three temperatures plus ambient temperature can be set up on a patch bay, and the timing command chassis then switches the environmental test chamber on and off on a pre-set time basis. The timing command chassis switches the stepper in the bridge-balance chassis from channel to channel, permits the "SADIC" to balance against the analog output signal of the transducer, then operates the printer to produce a permanent record of the data.

A program of temperatures can be arranged to test the transducers for zero drift over their operating temperature range. This program is completed on a fully automatic basis throughout the night and saves much valuable test time. Fig. 6 is a block diagram of the zero-drift instrumentation system. Data on zero drift, zero return, sensitivity, hysteresis, and linearity are printed on tape. A sample data record is shown in Fig. 7.

The principal result of this test method has been the substantial reduction of test time required and the increased

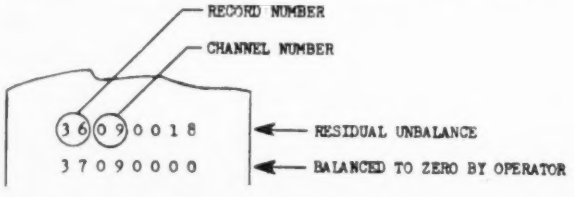

Fig. 7. Sample data record from printer.

accuracy of the test. Formerly, an average of 1.1 man days was required to completely test one pickup, whereas by this automatic means the equivalent test is performed in 0.15 man day.

A secondary result of this method is of no less import than the time factor. Most transducers exhibit to some degree a phenomenon known as "output drift," which is simply a change of output reading with time for a given constant input. This phenomenon is analogous to "creep" in stressed metals. Since the "time constant" of this phenomenon is generally short compared to the time required for manual calibration by conventional methods, errors due to output drift are obscured in the data. The higher speed capabilities of the automatic calibration system have revealed many new aspects of this "output drift" problem and have provided means whereby steps for the elimination of this error can be undertaken.

MANOMETER

Continued from page 1523

Zero adjustment is accomplished approximately by supplying the correct amount of mercury. The final adjustment can be made by the hand wheel. When the screw is turned in, it displaces some of the mercury, thus raising the level in the cistern. The adjustment is used only when the amount of mercury in the instrument is changed.

The manometer is provided with a level bubble and leveling screws to make sure that the column is precisely vertical. The top of the cabinet is made of two hinged pieces and not fastened so that an accidental leak would be dissipated through the top and do the least damage.

Each contact on the terminal ring is connected to one of several small neon lights bank-mounted on one of the doors. In parallel with each light is an outlet plug. To this can be plugged a cord leading to a supplementary light which can be located close to the manometer being tested. Thus the observer can be watching the pointer on

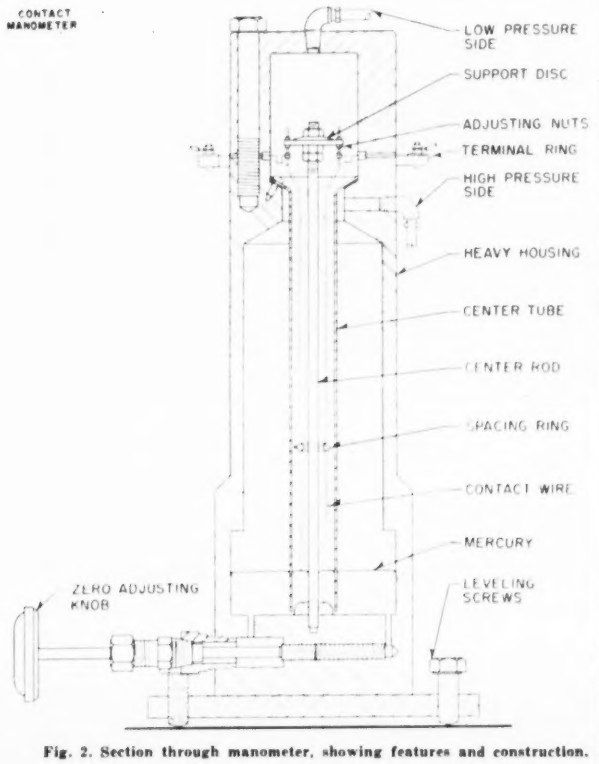

Fig. 2. Section through manometer, showing features and construction.

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the instrument being tested while the light, which is also observable, tells him when contact is made or broken between the mercury surface in the manometer and one of the contact wires. An isolating transformer is used to prevent short circuits through connecting tubing.

After the instrument temperature had been at the control value for at least 3 hours, the instrument was calibrated with the low-pressure side open to the atmosphere, by comparison with a primary standard (which is also of the electric-contact type) using a micrometer depth rod.

Density Correction

When the difference between two gas pressures is to be measured accurately at high pressure levels by the use of a manometer which depends upon a column of liquid, corrections must be made for the change in density of the gas over the short column. The correction is directly proportional to the head of liquid and, therefore, is less for mercury than for a lighter liquid.

The correction (C) in inches of water for change in air density is plotted on a chart so that rapid corrections can be made. As the manometer is for use mainly in checking transmitters whose ranges are 20, 50, and 100 inches of water for 12-psi. output, a correction chart has been made for each of the ranges. The correction in psi. output is plotted for each pressure setting and for pressure levels up to 1500 psi.

Operation

When the pressure level is being increased, it is necessary to keep the high-pressure side of the manometer always at a pres ure slightly above that of the low-pressure side, within the range of the manometer. This is to keep the mercury from being blown to the high-pressure side. It is done by controlling the opening of the by-pass valve. With the by-pass valve open just a little, air is let in through the high-pressure side. As the differential is increased and the manometer lights go on, the by-pass valve is slowly opened to keep the pressure differential within the range of the instrument being tested. Then the input valve is opened a little more until the pressure in the system increases slowly to the desired value when the input and by-pass valves are closed. To get the desired differential, air is let out from the low-pressure side when the by-pass valve is closed. When the pressure level is to be decreased, the air is let out from the low-pressure side while the by-pass valve is adjusted to maintain a small differential.

If the mercury surface in the center tube becomes contaminated, it can be cleaned to some extent by increasing the pressure in the tube until air bubbles slowly into the reservoir, carrying the scum with it. Sometimes, when the mercury flows back as the pressures are equalized, the small amount of scum remaining is deposited on the wall of the tube, leaving the mercury surface clean. Small particles on the mercury surface in the cistern do no harm.

The principal advantages of this manometer are (1) it is accurate to about 0.001-inch Hg. if mounted where building vibrations do not affect it and the mercury surface is clean, (2) there is no drainage error with mercury because mercury does not wet the walls of the tube and, therefore, no waiting between readings, (3) the correction for density of the air over the mercury surface is smaller for mercury than for lighter liquids, and (4) the contact-type manometer is a time saver for the type of tests for which it was designed. The pressure does not have to be held constant while two readings are made, one on the standard and the other on the instrument being tested. Readings are always made while the pressure is increasing or decreasing slowly.

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NUCLEAR REACTOR

Continued from page 1530

the form of uranyl sulphate dissolved in ordinary water. (This design has been called a "water boiler" because the heat of the reaction could cause the water to boil.) A reactor of this type has been in operation at Los Alamos since before 1945. The North Carolina State College project is noteworthy as the pioneering effort to put a reactor on a campus.

Swimming-pool Reactor

In some ways the most attractive reactor design yet released by the AEC for consideration by universities is the "swimming-pool" type (Fig. 2-4). This name is given because the active reactor core is immersed in a large tank of ordinary water. This large thickness of water on all sides serves not only as neutron moderator, but also as radiation shield—a function which in other designs requires bulky concrete walls. The experimenters can safely work directly over the reactor, with transparent water between them and the fuel elements (Fig. 2-5). Particularly for teaching purposes, this visibility would seem desirable. A 10-kilowatt reactor of this kind has been in use at Oak Ridge National Laboratory since 1950, principally for study of shielding problems.

There are of course many other possible designs, as shown in Table 1 and Fig. 1-2 of the previous chapter. Fig. 2-6 shows the JEEP reactor built at Kjeller, Norway. This 100-kilowatt reactor uses heavy water as moderator, and graphite as moderator-reflector. It was built by a competent team of scientists and engineers working almost entirely from information which had been openly published.

Considerations in Selecting a Reactor

The present policy of the Atomic Energy Commission seems to be to restrict development of new reactor designs to the national laboratories and to large industrial companies. There is every reason to suppose that universities can contribute significantly to reactor development and that they may be allowed the necessary information and

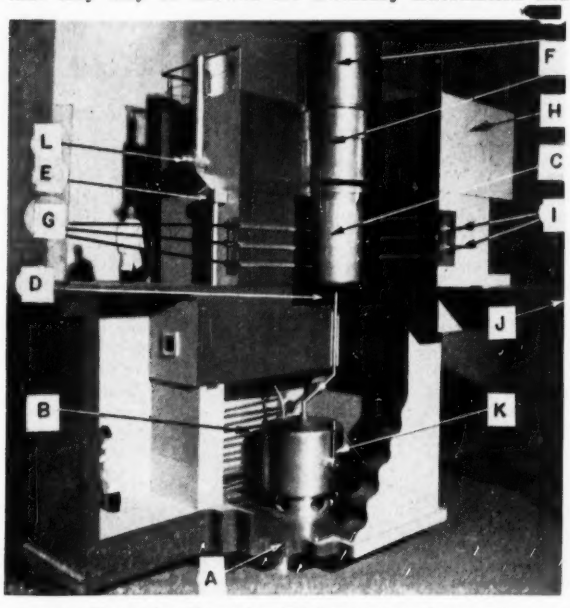

Fig. 2-6. The 100-kw. Norwegian JEEP reactor uses heavy water as a moderator, and graphite as moderator reflector. The parts: (A) floor of basement room, (B) heat exchanger, (C) reactor tank, (D) dump line from reactor tank, (F) tube for control plate counterweight, (F) layers of wood, lead, and cadmium that have replaced water-filled tanks, (G) irradiation tubes into reactor, (H) concrete shield, (I) leads to BF_3 control chamber, (J) floor of reactor room, (K) dump tank for D_2O, (L) reactor ventilator.

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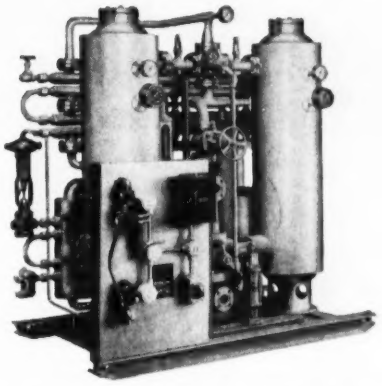

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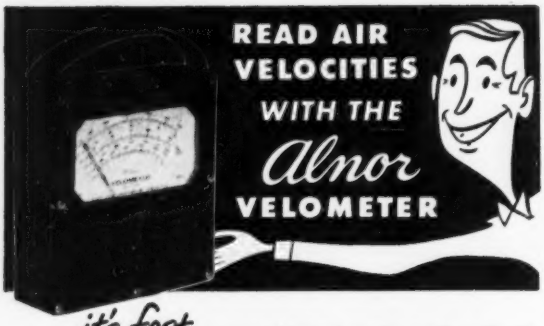

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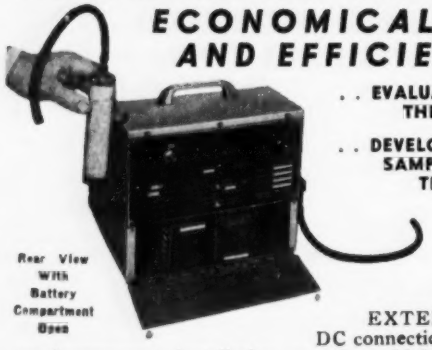

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facilities to do so. The initiative must come from the universities.

Until such a modified policy bears fruit, the university must choose one of the reasonably large number of reactors already declassified. The following are typical considerations involved.

Cost

A basic factor is cost. The North American graphite reactor costs approximately one million dollars. The North Carolina State College reactor and the swimming-pool reactor can be built for perhaps $300,000 to $500,000. Cost estimation is covered later in this series, but the cost estimate should include (1) cost of special materials, such as fuel or heavy water, which the AEC may or may not furnish at reduced or zero cost and (2) building, research facilities, and other auxiliary equipment.

Basic Use

With certain limits set on costs, the next problem is to decide what to buy—high power, intense neutron flux, or convenience and effectiveness in teaching or research. At present, and until universities are ready to participate in the development of practical power reactors, there seems to be no reason for a university to seek high power for its own sake. But intense neutron flux (which is desirable for some classes of experimental research) is related to power, at least when the other design factors are fixed. All three of the reactor types mentioned above are said to have a maximum thermal neutron flux of about 10^{12}; but the power is only 10 kw. for the water-solution reactor and 160 kw. for the graphite reactor.

The important thing to remember is that in buying a research reactor one buys neutrons—but it may make a great deal of difference whether the neutrons are available over a small area or over a larger area. For some experiments it is more advantageous to have an intense beam of neutrons active over a small area than to have the same number of neutrons spread over a larger area. In other experiments, the reverse might be true. From published data on the three reactor types discussed, it is easy to get the value of flux available at a point, but hard to estimate the area usefully available. The swimming-pool design is relatively well suited for irradiation of large targets.

Facilities

Careful attention must be given to the facilities, including (1) the *nature* of the experiments for which the reactor is to serve, (2) the *number* of experiments to be in progress at any one time, (3) the total *space* around the reactor needed for the apparatus involved in the experiments, (4) the *accessibility* of this space, not only for research personnel, but also for electrical power and other auxiliary services, and (5) the *shielding* of this space from stray nuclear radiation.

The pattern of arranging experiments around the reactor is established for the water-solution and graphite types. The reactor, encased in a substantial concrete shield, is in the middle of a large room, with floor space available on all sides of the reactor and possibly on platforms above floor level. The pattern is less clear for the swimming-pool type (Fig. 2-5). The top of the pool is available, and to some extent the sides. The problem which needs further work here is that of securing optimum experimental effectiveness without sacrificing simplicity of construction.

It must be remembered that some of the space around any reactor is reserved for control and measuring devices, inlet and outlet of cooling system, and maintenance fixtures.

As a final item in this brief list of considerations, the problem of the fuel cycle may be mentioned. The North American graphite reactor features a sealed-in fuel unit good for ten years of operation. This practically eliminates the problem of radioactive waste disposal and simplifies auxiliary plant requirements. If, however, the experimental program is to include a notable chemistry portion, the availability of the fission products is an advantage rather than a disadvantage because some of the most interesting research problems involve these materials. Any of the small

reactors will supply from a half to one megawatt-year of energy before the fuel needs reprocessing.

Safety in Controlling a Reactor

As reactor control and radiation protection is discussed in detail later in this series, controls will be presented here in only a general way. Control of any nuclear reactor must provide for starting up the reactor, operating it at some desired condition, and shutting it down when desired—all with some comfortable margin of safety. For a low-power (and therefore less dangerous) research reactor, control gear can be relatively simple, there may be relatively greater need for accurate control of *local* neutron flux at the locus of a particular experiment, and instrumentation must be flexible enough to keep adequate check on the diversity and changing nature of experiments—both as to the possible effects on the reactor level of the experimental apparatus, and as to the effects of the reactor on the apparatus, the experimental process, and the research workers.

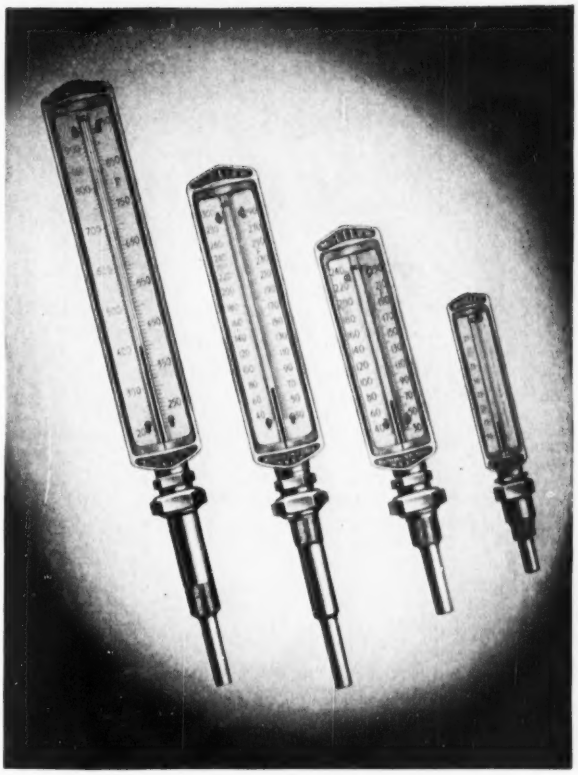
There are many methods of controlling a reactor. Reactivity—the property of the reactor which determines whether the nuclear fire is building up or dying down—depends more or less on everything in and around the reactor. For example, apparatus introduced into a reactor in an experiment must be carefully assessed as to its effect on reactivity. Reactivity is particularly sensitive to changes in amount or location of fuel, moderator, reflector, or absorber materials.

Highly absorbent materials, such as cadmium or boron, may be fabricated into rods which can easily be moved in or out of the reactor. These constitute the most widely used control method. Moving a control rod intends to damp down the reaction; moving one out promotes the reaction. To speak simply, we may say that control of a reactor involves the moving of control rods in accord with the wishes of the operator or with the demands of automatic safety systems.

The *control room* for a reactor has much the same appearance as the control room for any chemical or industrial process (Fig. 2-7). The operator sits at a control desk or console on which are mounted indicating instruments and manual switches. Around the console are grouped other instruments—controllers, alarms, and safety devices—usually mounted on upright panels. Within easy reach is a telephone by which the operator may receive information and transmit orders.

Consider now the way the operator proceeds to start up the reactor. The reactor, having been shut down, has all control rods fully inserted. There are very few neutrons in the reactor, few fission events are taking place, very little heat is being released. Before proceeding, however, the operator would like to know something about how many neutrons there are; so he consults the reading of a neutron-counting instrument. He then switches on a motor which starts to pull out a control rod. As the rod comes out, the neutron indicator is watched for signs of increased reactiv-

Fig. 2-7. The operator in the control room of the graphite-uranium reactor at Oak Ridge National Laboratory throws one of the switches that halt the chain reaction by driving boron steel control rods into the heart of the reactor. Shutdowns occur at least once weekly for withdrawal of radioisotopes, insertion of new material to be irradiated, maintenance work, and insertion of fresh uranium-fuel slugs.



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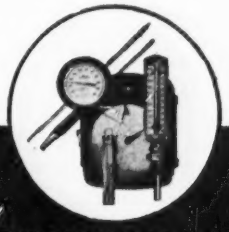

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ity. It is important to understand that a given reactivity corresponds to a given *rate* of change of neutron level. The problem, therefore, is to avoid pulling rods to the extent that the *rate* at which the neutron level rises becomes large enough to be dangerous. At the same time, one wants the start-up time to be reasonably short. Optimum performance in bringing the reactor level up to the maximum safe rate may be obtained with automatic servomechanism control of rod-pulling.

As the reactor level (the density of neutrons in the reactor) approaches the value at which the operator desires to hold it, he initiates a decrease of reactivity by insertion of rods and thus "levels off." Usually there are two kinds of control rods—"coarse" or "shim" rods for controlling large amounts of reactivity but capable only of slow motion, and "fine" or "regulating" rods for controlling small amounts of reactivity, but capable of rapid motion. Shim rods are used in the start-up, until approach to operating level requires the finer, faster regulating action.

As stable operation at a fixed level corresponds to zero reactivity, and since reactivity can be measured only indirectly by change of neutron level, it might seem that producing stable operation would be like trying to balance on a knife edge. That the operation is actually not troublesome is due to two factors—(1) a small departure or reactivity from zero gives only a small rate of change of neutron density, so that a change is usually detected before the rate becomes large, and (2) essentially all reactors have inherent stability in the temperature-dependence of reactivity. As neutron density increases and more heat is released by fission, the reactor temperature rises. It is a fortunate circumstance that the total effect of a temperature *increase* on the nuclear properties is to *decrease* the reactivity. Thus the reactor is to some extent self-regulating.

A prominent place on the control console is given to a push button or switch usually labeled "scram," by which the reactor may be shut down rapidly. Normal shutdown could be accomplished, of course, by relatively slow insertion of rods—the reverse of start-up. But the scram, or emergency, shutdown is accomplished by as rapid insertion as possible—often by free fall. As this is the one mechanism that *must* not fail, the operator likes to test it, and so uses it for what would otherwise be normal shutdowns. Automatic scram should be initiated from (1) excessively high neutron flux, (2) excessive neutron flux rate (often called short "period") of rise, (3) abnormally high temperatures, (4) excessive radiation around the reactor, and (5) possibly from other signals, depending on the particular reactor type.

The control room for a university reactor should be designed and located with a view to giving the operator the quiet, comfort, and uninterrupted freedom needed for reliable discharge of his duties. The informal atmosphere characteristic of universities is, in this matter, a hazard to be guarded against. The control room also should be laid out with ample space for accommodating the changing instrumentation needed to keep up with a diversified experimental program. Putting the control room on second-floor level makes it possible to put auxiliary instruments directly below, and also to have excellent access from below. If this arrangement is not feasible it is wise to have easily-removed false flooring in the control room to insure accessibility of electric wiring, pneumatic lines, or other instrumental connections.

The various instruments required for furnishing necessary information to the operator or to the control circuits are discussed in detail in the following chapter. The important signals are (1) neutron flux, both average values over the reactor and particular values at local sites, (2) neutron rate, or period, (3) temperatures, (4) power, which may be readily associated with signals indicating a performance of the cooling system, (5) external radiation levels at various points around the reactor, and (6) motion and position of control rods.

Design of control rods or other control elements is usually treated as part of reactor design. Specification of control equipment must join with reactor specifications. In the usual case (when the control elements are rods) the problem

is to fabricate the rods and connect them to motors for pulling and inserting, and also to provide for releasing them for free fall (or other rapid, scram insertion).

Motors, gear trains, valves, latches, and similar hardware are needed for these purposes. Shim rods, to be dropped for scrams, may be driven by straightforward, manually controlled motor drives, with the rods held to the driving elements by electromagnets. Interruption of magnet current releases the rods promptly. Regulating rod drive is accomplished best by servomechanism, particularly if a premium is to be placed on highly constant flux at a particular site. It is important, for safety, that electrical power failure be guarded against, and that all equipment should automatically return to a safe condition in event of power failure.

The over-all task of interpreting correctly and acting upon the totality of instrument signals coming to the control room is shared by the operator and by the automatic control circuits. It makes good sense to permit either the operator or the automatic control to initiate rod insertion at any time, but to require assent of both for all rod withdrawal, other than the small adjustments of the regulating rod. Design of the automatic circuits thus requires the building of an assemblage of amplifiers, relays, and switches into a kind of computer in which the human operator furnishes some, but not all, of the "brains." The decisions made by the controls designer and built into the hardware by the controls manufacturer, fortunately limit the operator's freedom and, therefore, his chance of making mistakes.

Conclusion

In view of the importance of a university-owned reactor both to the community and to the university itself, the availability of several suitable designs, and the comparative ease of installation and of operation, it is likely that if the university does not purchase a reactor now it may find itself before long a belated straggler on the road to a new approach to the teaching of science and to life.

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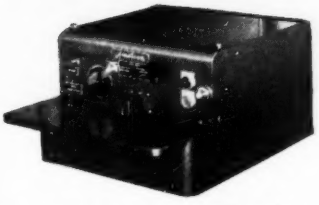

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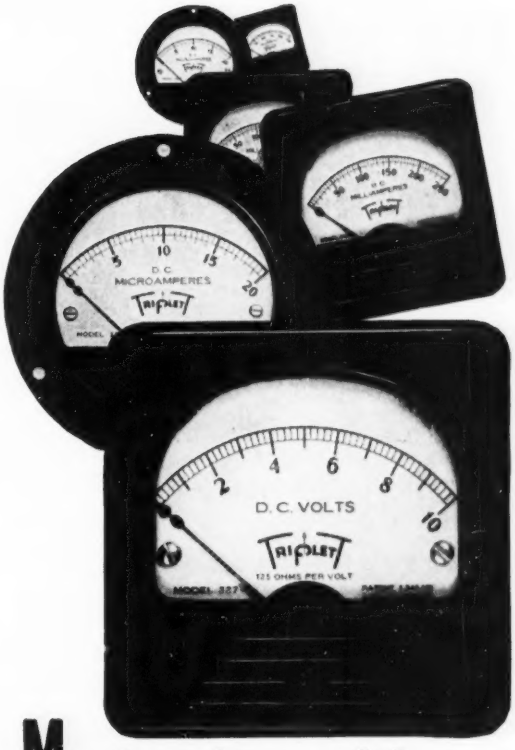

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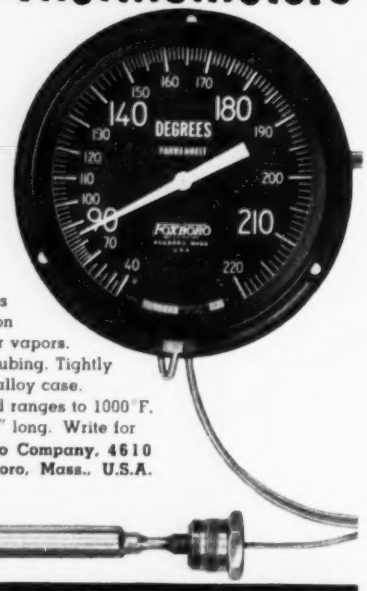

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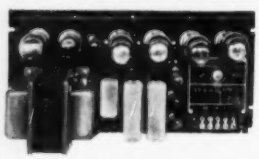

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HOW AUTOMATIC?

Continued from page 1483

These are computers, although it has not been the practice of the instrument engineer to call them that.

As we try to evaluate the role of computers in tomorrow's instrumentation picture, I believe that the quality control we want is most probably *not* synonymous with the popularized, complicated "giant-brain" computers. The large electronic brains are not only *not* necessary but will be too costly and complicated to be economically applied to the basic stages of quality determination except in unusual circumstances. The smaller computers, however, as a generic class, will be important in this function.

Computers are one of the "keys" to the future of our profession. They will broaden the field of instrumentation by the nature of their basic functions—to analyze, to tabulate, and to process the output of existing measuring instruments.

System Engineering

The future will put great emphasis on advance planning at all points in the process. We call this concept "system engineering" and consider it to be a joint responsibility of the user, the contracting engineer, and the equipment manufacturer.

We still know too little about the performance of systems even when we know a good deal about individual components. But there is much work going on in developing the means of knowing what to expect of a system as we put it together to perform a process.

Servomechanism Technique

Servomechanism techniques offer at present the one and only means of over-all performance prediction for a system and its instrumentation. We need such a tool; we must perfect it and we must apply it to our future process designs if we are to approach the ultimate in automation.

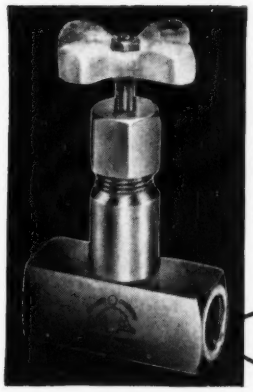
I think we all realize that there exists a sizable gap between what we do and the ideal goal. That goal is a two-part objective: (a) to design instruments and apply them in systems in the best possible way, and (b) to design our processes in such a manner as to take full advantage of the automatic control. In almost any mass production, even minor increases in efficiency are measurable in thousands or millions of dollars yearly.

Previous methods of applying automatic controls have left a number of important plant problems unsolved. The process designer still does not have answers to two big questions with respect to the use of instruments—namely, (1) how far can I go in cutting plant construction costs by designing to take full advantage of automatic control and (2) how much can the cost of operating the plant be reduced by such a design? Answers to such questions lie in a comprehensive study of process control which encompasses all facets of the problem—the process, the measuring element, the transmitter, the controller, and the valve.

The Automatic Factory

I have been disturbed to read the optimistic forecasts of "workless Utopias" and "manless factories" that have been appearing frequently of late, closely followed by pessimists who gloomily assert that this spread of automation will only further complicate our existence, bring about slavery to mechanization and a diminishing of our creativeness. The melancholy prophets and the starry-eyed optimists are succeeding only in distorting the significance of this entire evolutionary trend. It is time to interject some sober thought to counteract these dire predictions and sensationalized statements because reality, as usual, lies between the extremes.

Last month in New York, at an ASME meeting, our Vice President in Charge of Engineering—George Muschamp—



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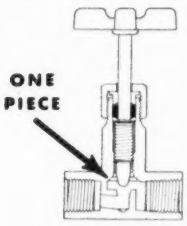

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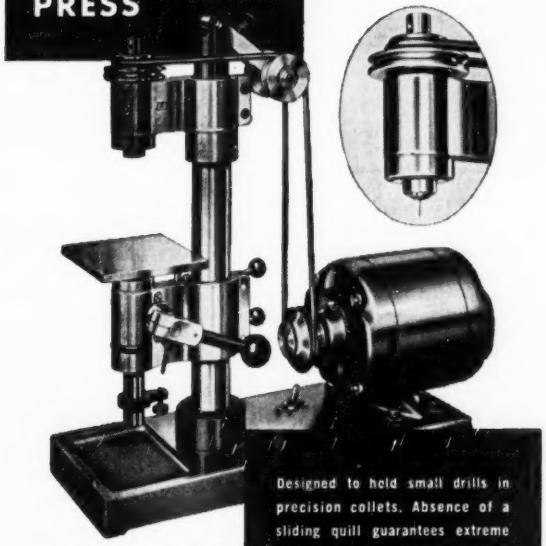

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joined a panel on the subject of the Automatic Factory. Here are some of the things he said:

> "There seems to be a tendency to underestimate the difficulty of performing automatically many operations common in present-day factories. Less credit than is due has been given the so-called routine worker. When one gets into these things, he finds that workers doing jobs even like tightening bolts are regularly performing sensing, safety, and other operations which is often difficult and expensive to do automatically. The Atomic Energy people discovered this when they had to perform, even semi-automatically, such operations as taking a stopper from a bottle and replacing it.
>
> "In speaking of the automatic factory, we must, as a practical matter, mean simply that we carry out as many of these operations automatically as is economically feasible at the moment.
>
> "Much comment has lately been directed to the possibility of undesirable replacement of workers by automation. That approach has led to negative argument concerned, I believe, with considerations which are not basic. The great concept, the core of the matter, is a positive, not a negative one. It is the multiplication of the effort of man through mechanical aids.
>
> "Can you imagine the number of people that would be required to produce *by hand* all the ingredients of all the things everyone wants? Isn't it clear that we simply haven't the people that would be required to produce these goods, except with vast mechanical aids. We had the choice of doing without these things or using machines to produce them. That choice was made a long time ago and it was made by all the workers. When they decide that they want more of these things, the question of the investment in the machines to make them available is introduced. This is the inherent force that drives us toward the automatic factory."

Let us look at it still another way.

We've been reminded many times how much the country's population growth means to our business future. From 1940 to 1950 the population has climbed some 20 million; in the present decade it is likely to grow that much again. By the time these youngsters grow up our present labor force will be hard-pressed to meet the new demands for cars, homes, etc. Hard-pressed, that is, unless technological advancements, automatic controls, and more and more instruments are utilized to ease the production burden.

Actually, much automation is now as close as the nearest instrument engineer and master mechanic, and much technology is lying there ready to use. But until the systems-engineering responsibility is settled, and until the determinants of product quality and safety are expanded and education is broadened, the partial or complete automatic factory will continue in the present somewhat chaotic state. Despite such promising solutions as servomechanism techniques, the over-all system approach is at an immature stage, particularly at the financial or management level because management, conditioned to traditional ratios of expenditures, has yet to fully recognize that systems-engineering, as a function, justifies its cost.

It is perhaps true that, because of the amazing acceleration of technical progress, we are the first generation of those who can see what tomorrow can be like. What is of primary concern to us, however, is how fast we can convert the preview into commonplace.

When we round up the possibilities of how to do it, consider the rewards, recognize the power of great reservoirs of brains working out problems one after the other, I am certain that we will go a long way beyond where we are today, and that great strides will be made in the next decade. I am intrigued, excited, and happy that I can have a little part in bringing it about—and I hope that you are too.

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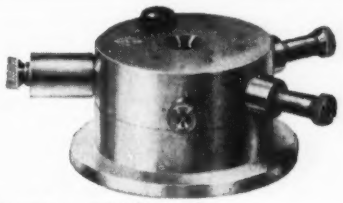

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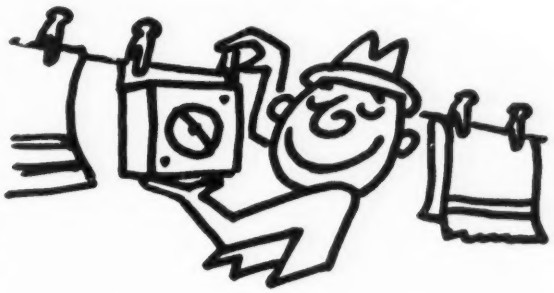

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INSTRUMENTS ON THE MARCH

New Principles, Applications, Non-commercial Developments

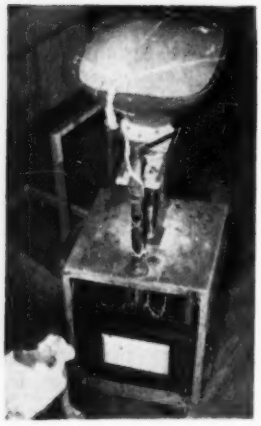
Rimbach and Hart Survey European Instrument Industry

RICHARD RIMBACH, publisher of *Instruments*, *Instrument Manufacturing*, and *Instrument & Apparatus News*, and Porter Hart, President of the Instrument Society of America, have recently completed a 5-week tour of England, Germany, Sweden, Italy, Switzerland, and France. They met with leading instrument manufacturers in London, Hannover, Duesseldorf, Frankfurt, Karlsruhe, Stuttgart, Munich, Zurich, Milan, Geneva, and Paris to discuss the condition and position of the European instrument industry. Also covered was the British Instrument Industries' Exhibit in London.

Most of the meetings and discussions were well attended, showing that the Europeans are greatly interested in cooperating with the American instrument industry. For example, 47 members of Italian instrument societies and industries attended a morning meeting at the Hotel Principe Savoia in Milan.

In addition to seeing the latest developments in the many plants visited, the American tourists noted that many American instrument manufacturers have agreements with British companies, but few with German manufacturers, and that there is great interest in Germany in starting an Instrument Society.

"Guinea Pig" Monitor



LANCASTER, PA.—The temperatures in straight-line exhaust ovens used in the Lancaster plant of RCA for baking glass-tube TV kinescopes are monitored by a "guinea-pig" tube and a recording potentiometer. The test unit is sent through the ovens at intervals, recording temperatures of several test points on the tube vs. position in the oven, thus providing accurate control data. The test set-up was developed in collaboration with the industrial division of Minneapolis-Honeywell Regulator Co., Phila. 44, Pa.

"TRODI"

During acceptance tests of aircraft, one of the basic data required is vertical component of the rate of descent just prior to touchdown on a landing surface. North American Aviation, Inc., in conjunction with the flight-test personnel at Patuxent Naval Air Test Center, Maryland, and the Bureau of Aeronautics in Washington, D. C., has developed a Touchdown Rate of Descent Indicator, or "TRODI."

A trihedral prism weighing less than 1¼ pound is the only part of the system that is installed on the plane. This prism (commonly called a corner reflector, a triple mirror, or a retroflective mirror) is available commercially. It intercepts and returns each of two beams of light projected from a projector-detector unit located near the runway on which the plane is landing.

To seek rate of descent, TRODI sends out two parallel beams of light, thin vertically and wide horizontally. They are one foot apart. The prism on the incoming airplane cuts the top beam, reflecting the light back to a photoelectric cell, which starts an electrical charge into a capacitor. The descending airplane then cuts the second and lower beam, reflects it, and stops the charge going into the capacitor.

The electrical charge stored during the interval between beams is quickly translated by TRODI from voltage to rate of descent in feet per second.

Aircraft Engine Analyzer

NEW YORK, N. Y.—Eastern Air Lines, Inc. announces that 30 airborne electronic engine analyzers will be installed in Super-Constellations so that flight engineers will be able to see how each spark plug, valve, magneto, or other component is behaving at all times during flight. Electronic patterns will detect, locate, and identify malfunction before serious damage occurs. The saving of one 18-cylinder engine will pay the cost of the analyzer ten times over, in addition to increased safety factor. The analyzer is made by Sperry Gyroscope Co., Great Neck, N. Y.

European Federation

PARIS, FRANCE—A European Federation of Chemical Engineering was formally inaugurated at a Foundation Meeting held in the Maison de la Chimie in Paris on the 20th of June, 1953. The purpose of this Federation is to promote European co-operation in the fields of chemical engineering and equipment. Many societies in Spain, Yugoslavia, Germany, Finland, Portugal, France, Germany, Norway, Denmark, Luxemburg, Austria, Switzerland, and Great Britain are cooperating. Activities of the Federation are managed by a committee, and the following gentlemen were elected members of this Committee of Management: Herbert Bretschneider, Germany; Hans C. Egloff, Switzerland; Francis A. Freeth, Great Britain; and Jean Gérard, France.

The General Secretariats of the European Federation of Chemical Engineering are located in the Maison de la Chimie, 28 Rue Saint-Dominique, Paris, and in the Dechema-Haus, Frankfurt am Main, Rheingauallee, 25.

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MANUFACTURERS' NEW LITERATURE

In this department we report new literature, pertaining to instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 1583.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

PROCESS CONTROL

Electronic Controllers. New 16-page illustrated Bulletin B226 describes maker's new line of "Free Vane" electronic indicating and recording controllers for process variables.—The Bristol Co., Waterbury 20, Conn.

Circle **301** on inquiry card.

Blower Control. New 4-page illustrated Bulletin 158 describes maker's constant air-weight control for cupola blowers, its two parts (jet pipe relay and signal system), and gives principles and specifications.—Askania Regulator Co., 240 E. Ontario St., Chicago, Ill.

Circle **302** on inquiry card.

VALVES

Valves. New 8-page Specification Sheet 414 illustrates and describes design data, general specifications and operating characteristics for maker's spring and springless types "Air-O-Motor" operators.—Minneapolis-Honeywell Regulator Co., Industrial Div. Phila., 44, Pa.

Circle **303** on inquiry card.

Non-return Valve Operator. New 4-page illustrated Bulletin 160 describes maker's non-return valve operator for making a hydraulically operated non-return or check valve of a simple butterfly valve. Gives construction, principles, and operation.—Askania Regulator Co., 240 E. Ontario St., Chicago, Ill.

Circle **304** on inquiry card.

Combination Air-release, Air-inlet Valve. New 4-page Bulletin 1203 illustrates and describes combination air-release and air-inlet valve, listing discharge capacities, uses, weights and dimensions.—Simplex Valve and Meter Co., 68th and Upland Sts., Phila., Pa.

Circle **305** on inquiry card.

Control Valves. New 12-page Catalog 531 describes, illustrates, and gives performance data on maker's line of air and hydraulic control valves and valve couplings. Lists sizes, actions, permissable pressures, temperatures, etc.—C. B. Hunt & Son, Inc., Salem, Ohio.

Circle **306** on inquiry card.

Multi-range Flow Control Valves. New 2-page Bulletin VFC-1 illustrates and describes maker's multi-range flow control valves, 2-port types and with checks. Includes dimensions, typical circuits and ordering information.—The Denison Engineering Co., Columbus 16, Ohio.

Circle **307** on inquiry card.

TEMPERATURE

Temperature Console. New 4-page illustrated Bulletin ND46-33A(2) describes electronic console indicator for rapid scanning and logging of 200 thermocouple temperatures.—Leeds and Northrup Co., 4934 Stenton Ave., Phila., Pa.

Circle **308** on inquiry card.

Thermostatic Bimetals. New 8-page illustrated technical digest, "Fundamentals of Bimetal Performance," gives information on maximum stress versus temperature, methods for testing devices using thermostatic bimetals, and selection of proper metals for bimetallic devices.—W. M. Chace Co., 1600 Beard Ave., Detroit, Mich.

Circle **309** on inquiry card.

Temperature Control. New set of three 4-page bulletins describe application of "Weather-Flo" heat controller to hot water and warm air heating systems.—Automatic Devices Co., Western Springs, Ill.

Circle **310** on inquiry card.

PRESSURE

High-vacuum Apparatus. New 60-page illustrated Bulletin 10F gives data on planning high-vacuum systems and on low-pressure technique, plus listing maker's line of high-vacuum pumps and accessories.—Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.

Circle **311** on inquiry card.

Industrial Gages, Thermometers. New 24-page illustrated Catalog 101 describes maker's pressure, compound, freon, ammonia, and hydraulic gauges, and line of industrial thermometers, plus tables showing temperature conversion, hydraulic ram capacities, decimal equivalents, and linear-measurements conversion.—United Instrument Co., 574 President St., Brooklyn, N. Y.

Circle **312** on inquiry card.

Ultrasonic Transducers. New 8-page issue of "Brush Strokes" (Vol 3, No. 2) describes mechanical, magnetostrictive, piezoelectric, and ceramic ultrasonic transducers, including principles, uses, and possibilities.—Brush Electronics Co., 3322 Perkins Ave., Cleveland, Ohio.

Circle **313** on inquiry card.

Altitude-Pressure Relations. New pocket-size plastic conversion table gives altitude-pressure and temperature-pressure conversion relations.—Tenney Engineering, Inc., 26 Avenue B, Newark, N. J.

Circle **314** on inquiry card.

FLOW

Flow Meters. New 4-page issue (Vol. 2 No. 8) of "Ratonews" features articles on "Foamite" air-foam fire truck designed for protection of petroleum storage areas, showing use of maker's flow meters and "Ratosleeve" meters.—Fischer and Porter Co., Hatboro, Pa.

Circle **315** on inquiry card.

Centrifugal Pumps. New 4-page Bulletin W-300-B4 describes maker's line of standard end suction centrifugal pumps, including capacities and heads.—Worthington Corp., Harrison, N. J.

Circle **316** on inquiry card.

LEVEL

Liquid Level Gages. New 4-page bulletin describes, illustrates and gives performance data on maker's line of transparent-type gages for noting level, color, and density of liquids.—Jerguson Gage & Valve Co., 87 Fellsway, Somerville, Mass.

Circle **317** on inquiry card.

Liquid Level Control. New 6-page bulletin gives general information, principles of operation, specifications, probes, fittings, and applications of maker's electronic liquid level controls, "Model WS."—Haledy Electronics Co., 57 William St., New York, N. Y.

Circle **318** on inquiry card.

GAGING

Gage Blocks. New 20-page illustrated catalog describes features of maker's line of gage blocks, sine bars, tri-squares, etc.—Jansson Gage Co., 19204 Glendale Ave., Detroit, Mich.

Circle **319** on inquiry card.

Gages. New 4-page illustrated brochure describes maker's line of flush pin, contour, snap, concentricity, and profile gages.—Jansson Gage Co., 19204 Glendale Ave., Detroit, Mich.

Circle **320** on inquiry card.

Calipers. New 4-page bulletin describes and illustrates maker's "Mauser" vernier caliper.—George Scherr Co., Inc., 200 Lafayette St., New York, N. Y.

Circle **321** on inquiry card.

Measuring Microscope. Two new 2-page Bulletins describe and list applications of maker's "Optometer" 50-power measuring microscope for shop measurements.—National Instrument Co., 5005 Queensbury Ave., Baltimore, Md.

Circle **322** on inquiry card.

TESTING

Paint Testing Instruments. New 48-page illustrated 1953 catalog describes equipment for testing paint hardness, color, gloss, etc., plus petroleum and steel drum testers.—Gardner Lab., Inc., Bethesda 14, Md.

Circle **323** on inquiry card.

Component Shock Machines. New 4-page Bulletin 535 describes and gives performance data on maker's "20 VI" shock machine for developing and qualification testing of equipment components that must withstand shock.—The Barry Corp., 880 Pleasant St., Watertown, Mass.

Circle **324** on inquiry card.

Test Cabinets. New 4-page Bulletin 108-102 describes maker's line of test chambers for altitude simulation between atmospheric pressure and 100,000 feet, temperature control between minus 100 and plus 200 deg. F., and humidity control between 20 and 95 percent.—Hudson Bay Div., Refrigeration Systems Inc., 646 W. Washington Blvd., Chicago, Ill.

Circle **325** on inquiry card.

STRAIN, VIBRATION

Strain Gages. New 12-page Bulletin 7-53 gives price list and specifications for maker's SR-4 strain gages, instruments, and accessories.—Baldwin-Lima-Hamilton Corp., Phila. 42, Pa.

Circle **326** on inquiry card.

Strain Indicator, Bridge Balance. New 4-page illustrated Bulletin 105 presents features and specifications of maker's "Model 82-6" bridge-balance and strain-indicator unit.—The Heiland Research Corp., 130 E. 5th Ave., Denver, Colo.

Circle **327** on inquiry card.

Hand Vibrograph. New 2-page illustrated Bulletin 206 E presents features and uses of distributor's hand vibrograph, an imported (Askania) recording instrument for vibration and

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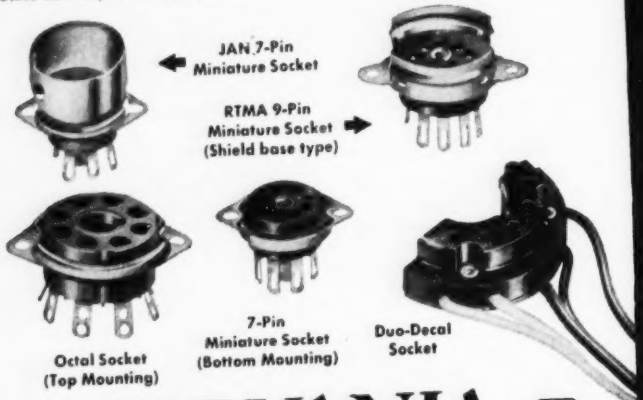
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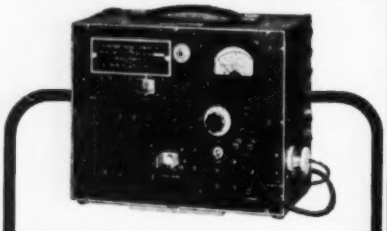

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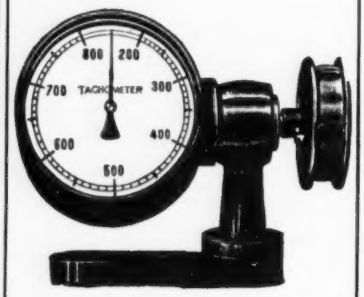

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NEW LITERATURE

acceleration.—European Products Importing Co., Inc., 154 Nassau St., New York, N. Y.

Circle **328** on inquiry card.

ANALYTICAL

Analytical Service. New 12-page Bulletin 7-53-1813A describes uses, instruments available, sample requirements, and other information on mass-spectrometer analytical service.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **329** on inquiry card.

pH Control. New 12-page technical Bulletin 55 outlines several typical systems of automatic pH control in boiler feed-water treatment.—Milton Roy Co., Station E, 1300 E. Mermain Lane, Phila., Pa.

Circle **330** on inquiry card.

Gamma-correcting Fan-scale Calculator. New 4-page illustrated Bulletin FSC 4-53 describes basic principle, method of operation, and dimensions of maker's fan scale calculator for spectrochemical calculations.—Jarrell-Ash Co., 26 Farwell St., Newtonville, Mass.

Circle **331** on inquiry card.

Thermal Conductivity Apparatus. New 4-page illustrated Bulletin GMH-853 lists applications, components, general data, and table of typical deflection values for maker's "Gas Master" and "Gas Master Helper" thermal-conductivity-type gas analyzers.—Gow-Mac Instrument Co., 100 Kings Rd., Madison, N. J.

Circle **332** on inquiry card.

Gas Analysis Equipment. New 48-page illustrated Catalog 81 lists and describes equipment and accessories for gas analysts, plus outlining analyzing methods.—Burrell Corp., 2223 Fifth Ave., Pittsburgh, Pa.

Circle **333** on inquiry card.

Clinical Laboratory X-ray Methods. New 8-page illustrated Booklet (P.L.I. Contribution 55) describes "X-Ray Methods of Possible Use in Clinical Laboratories," by William Parrish.—Philips Labs., Inc., Irvington-on-Hudson, N. Y.

Circle **334** on inquiry card.

OPTICAL

Optical Instruments, Components. New 8-page illustrated Bulletin RD describes maker's reticles, prisms, optical flats, and other precision optical parts, and manufacturing facilities and processes.—W. & L. E. Gurley, Troy, N. Y.

Circle **335** on inquiry card.

Illumination Meter. New 1-page Bulletin S156 describes and presents specifications for maker's low-level illumination meter for quantitative measurement of light as low as 0.005 footcandles.—Specialties, Inc., Skunks Misery Rd., Syosset, L. I., N. Y.

Circle **336** on inquiry card.

RADIOACTIVITY

Radioactivity Instrumentation. New 12-page illustrated Bulletin 53-1 gives functional description, dimensions, and specifications for maker's scalers, voltage plug-in units, geiger tubes, shields, counters, timers, etc.—Nucleonic Co. of America, 497 Union St., Brooklyn, N. Y.

Circle **337** on inquiry card.

Radiological Electrometer. New 4-page Bulletin 110 describes and illustrates "Farmer-Baldwin" electrometer for use with small ionization chambers to measure X and gamma radiation.—The Atomic Center, 489 Fifth Ave., New York, N. Y.

Circle **338** on inquiry card.

COMPUTING

Sine-Cosine Mechanism. New 2-page Catalog Sheet 304062 gives features, application, and specifications for maker's hollow-shaft differential, miniaturized precision computer for converting angular rotational movement into linear sine or cosine movements.—Librascope, Inc., 1607 Flower St., Glendale, Calif.

Circle **339** on inquiry card.

Computers, Timers, Coders. New 20-page illustrated brochure describes facilities and experience of maker of electronic timers, coders, computers, servomechanisms, telemetering equipment, etc.—Electronic Engineering Co. of Calif., 180 S. Alvarado St., Los Angeles, Calif.

Circle **340** on inquiry card.

Analog-to-Digital Conversion. New 8-page bulletin "An Analogue to Digital Conversion System with Printed Decimal Read-Out" describes circuits, principles, and operation of maker's analog-to-digital converter-printer.—Clary Multiplier Corp., Engineering Dept., San Gabriel, Calif.

Circle **341** on inquiry card.

Analog Computer. New 8-page catalog lists maker's line of unitized analog computing devices such as integrating, differentiating, adding, coefficient, and inert-zone components.—George A. Philbrick Researches, Inc., 230 Congress St., Boston, Mass.

Circle **342** on inquiry card.

Quality Control. New 35-page booklet furnishes information on computing work in quality control. First part reviews mathematic principles; second part presents instructions on applying maker's adding-calculator to computations.—Monroe Calculating Machine Co., Inc., Orange, N. J.

Circle **343** on inquiry card.

COUNTING, TIMING

Impulse Counters. New 4-page bulletin 57002 describes distributor's Swiss-made miniature panel-mounted solenoid-operated remote impulse counters with reset device.—Landis & Gyr Inc., 45 W. 45 St., New York, N. Y.

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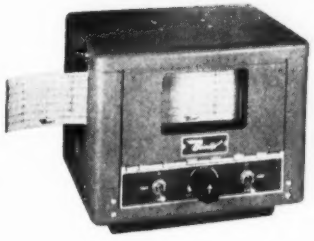

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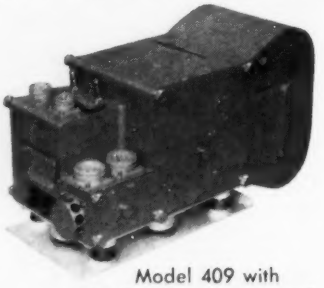

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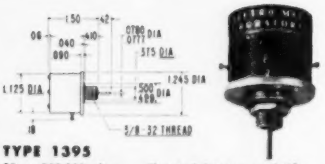

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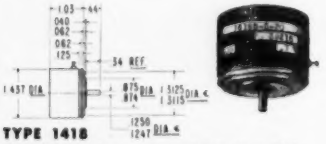

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NEW LITERATURE

Frequency Counters. New 4-page illustrated issue (Vol. 4 No. 11-12) of "hp Journal" gives operating principle, features, and specifications for maker's "Model 524A" frequency counter and "Model 512A" frequency converter which extends frequency measurements to 100 megacycles.—Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

Circle **345** on inquiry card.

Electronic Counters. New 2-page illustrated Bulletin 353 lists features, applications, application data, and specifications for maker's "Series GW" cold-cathode predetermined electronic counters.—Hadley Electronics Co., 57 William St., New York, N. Y.

Circle **346** on inquiry card.

Timers, Synchronous Motors. New 4-page illustrated bulletin lists application, operation, features, and range of maker's large line of timing devices and synchronous motors.—R. W. Cramer Co., Inc. Box 32, Centerbrook, Conn.

Circle **347** on inquiry card.

RECORDING

Recording Oscillographs. New 38-page illustrated catalog presents specifications, features, operations and applications of maker's galvanometers, multichannel oscillograph recorders, and portable oscillograph recorders. Includes principles and selection data.—Heiland Research Corp., 130 E. Fifth Ave., Denver, Colo.

Circle **348** on inquiry card.

Recording Potentiometer. New 14-page illustrated Booklet P-2-A (5-52) describes all features of maker's new simplified recording potentiometer with interchangeable parts. Includes construction features.—Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Circle **349** on inquiry card.

Recording Oscillograph. New 4-page illustrated Bulletin 101-8-53 lists standard and custom features available in maker's "Type-J" recording oscillograph.—William Miller Instruments, Inc., 325 N. Halstead Ave., Pasadena, Calif.

Circle **350** on inquiry card.

Magnetic Recorder. New 4-page illustrated Bulletin DS-3-1-3 gives applications, description, accessories, performance characteristics and specifications for maker's wide-range direct magnetic recorder.—Ampex Corp., 934 Charter St., Redwood City, Calif.

Circle **351** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Magnetic Clutch. New 2-page Bulletin DL-C 311 describes and presents detailed performance specifications and curves on maker's magnetic fluid

clutch metering and positioning movement for recording use. Includes clutch principles.—Texas Instruments Inc., 6000 Lemmon Ave., Dallas, Tex.

Circle **352** on inquiry card.

Research Instrumentation. New 6-page illustrated Bulletin 14-1 describes various instruments useful to research men—function plotters, recorders, converters, amplifiers, etc.—Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **353** on inquiry card.

Electronic Test Equipment. New 24-page illustrated catalog gives uses and specifications for maker's radio and television testing equipment, including oscilloscope, tracers, signal generators, etc.—Philco Corp., Accessory Div., Phila., Pa.

Circle **354** on inquiry card.

Electronic Test Equipment. New 8-page bulletin presents features and characteristics of maker's electronic test equipment—constant-amplitude signal generator, oscilloscopes, pulse generators, etc.—Tektronix, Inc., Sunset Highway and Barnes Rd., P.O. Box 831, Portland, Ore.

Circle **355** on inquiry card.

Electronic Test Equipment. New 16-page illustrated catalog describes maker's line of unassembled electronic test equipment in kit form.—Heath Co., Benton Harbor, Mich.

Circle **356** on inquiry card.

Amplifier Systems. New 9-page Bulletin 107 presents features, construction and specifications of maker's "Model 119" carrier amplifier system, for oscillographic recording.—The Heiland Research Corp., 130 E. Fifth Ave., Denver, Colo.

Circle **357** on inquiry card.

Oscillograph-Voltmeter. New 4-page bulletin describes and gives complete technical specifications for maker's "Type 322-A" dual-beam cathode-ray oscillograph with built-in independent voltage calibration for both beams.—Allen B. DuMont Laboratories, Inc., 760 Bloomfield Ave. Clifton, N. J.

Circle **358** on inquiry card.

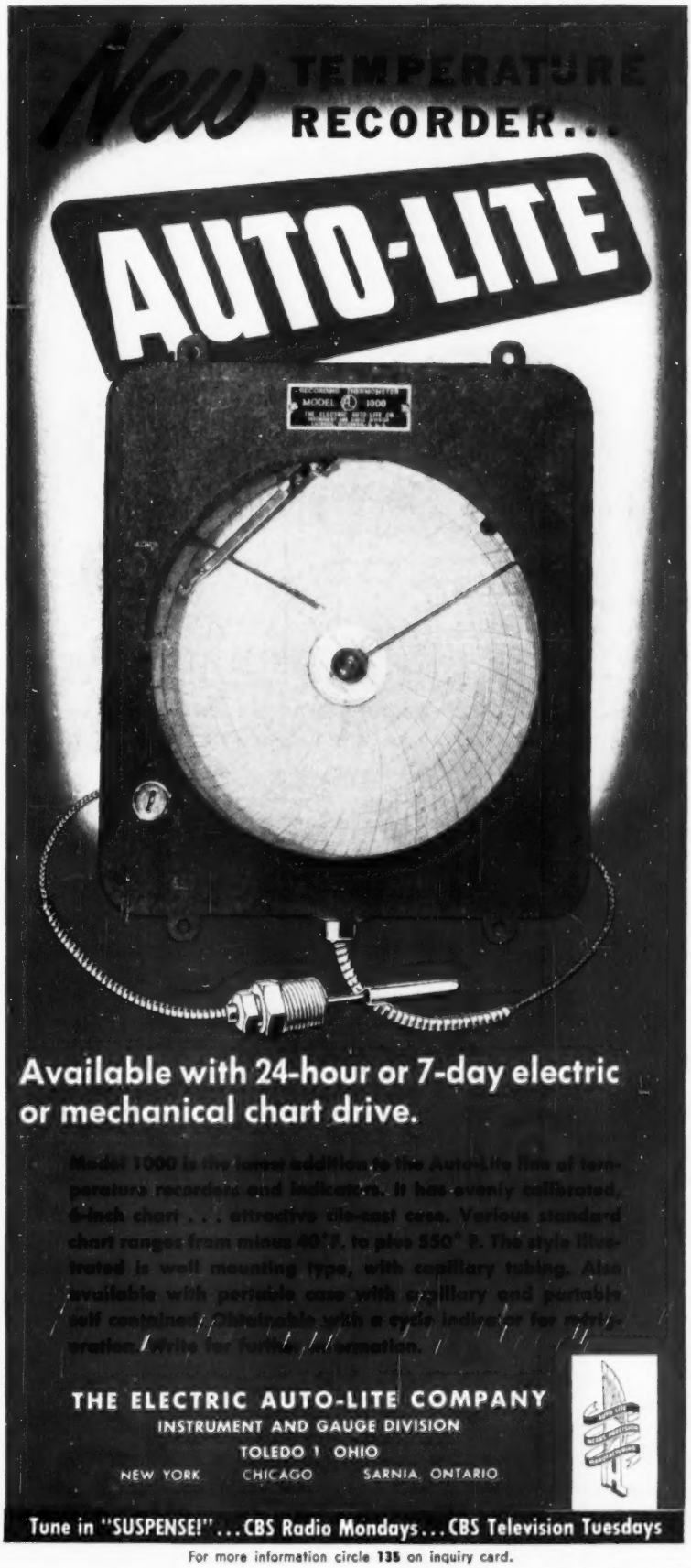
Amplifiers. Two new 2-page bulletins present features, specifications and diagrams on maker's subminiature a-c amplifier "type 2607" (for use with high-impedance piezoelectric and photocell pickups) and cathode followers with high input impedance and linear output.—Endevco Corp., 689 Fair Oaks Ave., Pasadena, Cal.

Circle **359** on inquiry card.

High-gain Amplifier. New 4-page illustrated Bulletin 100-8-53 gives performance specifications and general description of maker's "Type A-6" high-gain amplifier for use with oscillographs, strain gauges, etc.—William Miller Instruments, Inc., 325 N. Halstead Ave., Pasadena, Calif.

Circle **360** on inquiry card.

Admittance Meter. New 8-page illustrated issue Vol. 28 No. 3 of "Experimenter" explains applications of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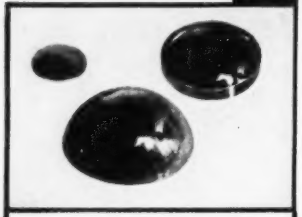

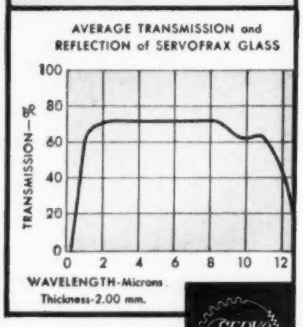

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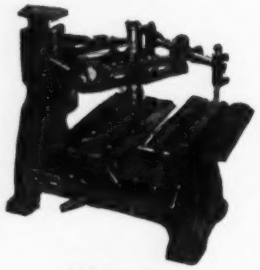

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NEW LITERATURE

"Type 1602-B" admittance meter to VHF and UHF bands.—General Radio Co., 275 Massachusetts Ave., Cambridge, Mass.

Circle **361** on inquiry card.

Plug-in Circuits. New 12-page Catalog C-3 describes maker's line of packaged plug-in circuits which may be dis-assembled, including design, applications, and specifications, plus 26 types of plug-in circuits available on order.—Plug-In Div., Electronic Engineering Co., 180 S. Alvarado St., Los Angeles, Calif.

Circle **362** on inquiry card.

Power Supplies. New 8-page illustrated Bulletin 54A gives general description, features, and specifications of maker's line of electronic regulated power supplies.—Oregon Electronics, 2232 E. Burnside St., Portland, Ore.

Circle **363** on inquiry card.

Instrument Power Supply. New 4-page Bulletin 201 gives description, specifications, installation, and applications for maker's "Model 201" instrument power supply for bridges, potentiometers, etc.—White Instrument Labs., 203 Riverside Dr., Austin, Texas.

Circle **364** on inquiry card.

Microwave Instruments. Three new bulletins describe and give specifications for maker's microwave and radar components, electronic instruments, and test equipment, including wattmeters, phasemeters, etc.—Cubic Corp., Scott and Canon Sts., San Diego, Calif.

Circle **365** on inquiry card.

Miniature Volt-Ohm Meter. New 1-page data sheet gives description and specifications for maker's miniature "Multitester" combination volt-ohm meter.—International Instruments Inc., P.O. Box 2954, New Haven, Conn.

Circle **366** on inquiry card.

Resonance Meter. New 4-page bulletin presents specifications, features, and uses of maker's resonance meter and RF detector with impedance and inductance measuring accessories.—Oregon Electronic Mfg. Co., 2232 E. Burnside St., Portland, Oregon.

Circle **367** on inquiry card.

Electrostatic Locator. New 1-page Bulletin S155 describes and illustrates maker's "Electrostatic Locator, type D," to detect electrostatic charges and induction.—Specialties, Inc., Skunks Misery Rd., Syosset, L. I., N. Y.

Circle **368** on inquiry card.

Dynamic Measuring Devices. New 4-page Bulletin 612aE describes and lists applications and technical data for distributor's "Askania IDM" carrier-frequency-type inductive dynamic-measuring device for force, vibration, acceleration, displacement, pressure, etc.—European Products Importing Co., Inc., 154 Nassau St., New York, N. Y.

Circle **369** on inquiry card.

TV Servicing. Vol. 20, No. 1 issue of "Sylvania News" features articles on transistors, TV servicing, and re-replacements.—Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.

Circle **370** on inquiry card.

RELAYS, SWITCHES

Relays, Timers. New 20-page illustrated Catalog H describes maker's large line of relays and timers, including power relays, sensitive relays, sequence relays, relay-transformers, etc. —Struthers-Dunn Inc., 150 N. 13 St., Phila., Pa.

Circle **371** on inquiry card.

Plug-in Relays. Five new 2-page Bulletins (1800 to 1804) give specifications, dimensional drawings, and wiring diagrams for maker's plug-mounted relays.—Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago, Ill.

Circle **372** on inquiry card.

Time Delay Switch. New 4-page illustrated bulletin presents features, operation, electrical data, and typical applications of maker's time delay switches.—AGA Div., Elastic Stop Nut Corp., Elizabeth 3, N. J.

Circle **373** on inquiry card.

Electronic Relay. New 2-page illustrated brochure describes and gives specifications, dimensional sketches, and technical data on maker's "Model SS" electronic pilot relay that operates on 2-ua. current.—Haledy Electronics Co., 57 William St., New York, N. Y.

Circle **374** on inquiry card.

High-pressure Switch. New 2-page issue (Vol. 1, No. 24) of "Newsletter" describes maker's high-pressure "Kilotrol" switch.—Cook Electric Co., 2700 N. Southport Ave., Chicago, Ill.

Circle **375** on inquiry card.

Push-button Switch Assembly. New Data Sheet 77 gives features and other pertinent data on maker's "IPB 4" push-button assembly for panel mounting.—Micro Div., Minneapolis-Honeywell, Freeport, Ill.

Circle **376** on inquiry card.

TRANSISTORS, TUBES

Point-contact Transistors. New Bulletin DL-S 312 gives specifications and electrical data on maker's hermetically sealed point-contact transistors with special section on theory and application.—Texas Instruments Inc., 6000 Lemmon Ave., Dallas, Texas.

Circle **377** on inquiry card.

Transistors, Accessories. New bulletins describe "Model TT-11" transistor tester, "Model CC-60" constant current converter, and "Model 110" transistor power supply. Bulletin also available describes types of transistors commercially available, manufacturers, and supplementary data.—Electronic Research Associates, Inc., Box 29, Caldwell, N. J.

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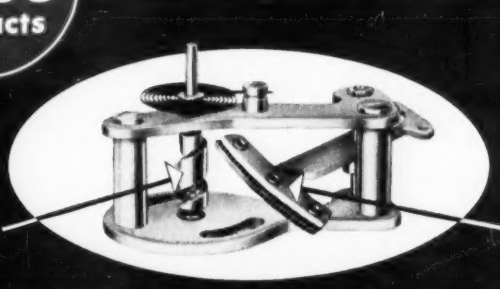

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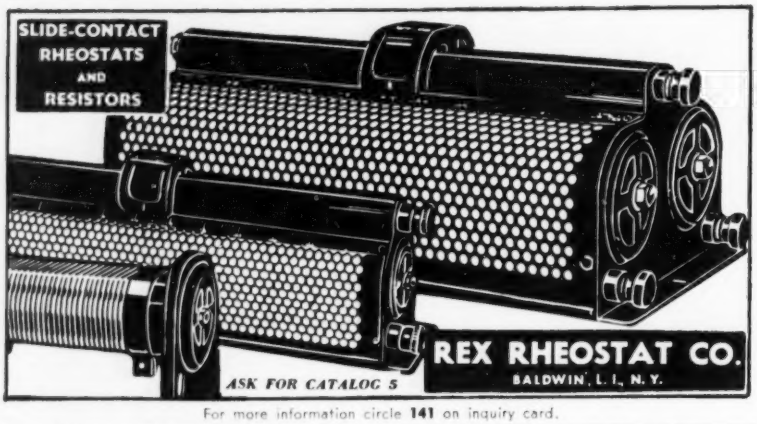

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NEW LITERATURE

Electronic Tubes. New Bulletins PL -4D21, PL-R1, and PL-5C22 describe maker's radiation-cooled power tetrode, high-voltage high-peak-current vacuum relay, and pulse-power-output hydrogen thyratron.—Penta Laboratories, Inc., 216 N. Milpas St., Santa Barbara, Calif.

Circle **379** on inquiry card.

Oscillograph Tubes. New 12-page Bulletin 5ABP1-7-11-3-53 gives tentative data on maker's oscillograph tubes Types 5ABP1, 5ABP7, and 5ABP11 with electrostatic focus and deflection.—Tube Dept., Radio Corp. of America, Harrison, N. J.

Circle **380** on inquiry card.

Field Testing Hot-cathode Gas Tubes. New 8-page Bulletin AN-157 describes basic pulse-emission circuit for testing hot-cathode gas tubes to detect both complete failures and "marginal" tubes.—Tube Dept., RCA, Harrison, N. J.

Circle **381** on inquiry card.

Beam Power Amplifier. New 4-page Bulletin 12AQ5 gives tentative data on 7-pin miniature beam power amplifier for use as output amplifier of radio receivers.—Tube Dept., RCA, Harrison, N. J.

Circle **382** on inquiry card.

ELECTRONIC COMPONENTS

Electronic Components. New 268-page illustrated and indexed 1954 Catalog 135 lists distributor's large line of radio, television, and industrial electronic components, including tubes, test instruments, transformers, capacitors, counters, and 20,000 other items.—Allied Radio Corp., 100 N. Western Ave., Chicago, Ill.

Circle **383** on inquiry card.

Electrical Insulating Materials. New 140-page Catalog 15 lists sizes and prices of maker's line of electrical insulating materials.—Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.

Circle **384** on inquiry card.

Electronic Components. New 62-page 1953 catalog describes maker's line of plugs, sockets, jacks, terminal strips, binding posts, fuses, and connectors.—Hugh H. Eby, Inc., 4700 Stenton Ave., Phila., Pa.

Circle **385** on inquiry card.

Glass Seals. New 36-page Catalog 453 presents specifications, performance information, and detailed drawings on maker's line of multi-terminal headers, diode and transistor bases, crystal holders, stand-off terminals, "Kovar" glass windows," etc.—Stupakoff Ceramic and Mfg. Co., Latrobe, Pa.

Circle **386** on inquiry card.

Microwave Components. New 4-page illustrated Bulletin gives maker's line of electronic and microwave equipment—transformers, attenuators, frequency meters, and waveguide

bends.—Nassau Research & Development Assoc. Inc., 66 Main St., Mineola, N. Y.

Circle **387** on inquiry card.

Resistors. New 2-page June-July issue of "Ohmite News" describes maker's wire-wound resistors, ceramic open-type tap switches, and color coder.—Ohmite Mfg. Co., 4835 Flourney St., Chicago, Ill.

Circle **388** on inquiry card.

Capacitors. New 4-page brochure presents illustrations, specifications and applications for maker's "Polycon" (polystyrene) and "Mylar" capacitors.—Southern Electronics Co. 239 W. Orange Grove Ave., Burbank, Cal.

Circle **389** on inquiry card.

Miniature Capacitors. New 4-page Bulletin NB-151 lists features, characteristics, and test data of maker's miniature tubular metal-cased capacitors.—Cornell-Dubilier Electric Corp., 333 Hamilton Blvd., S. Plainfield, N. J.

Circle **390** on inquiry card.

Electronic Components, Instruments. New 16-page Feb.-Mar. Bulletin illustrates and describes electric components and instruments available from distributor. Includes fractional-hp. motors, geiger counter tubes, survey meters, microscopes, selector switches, sockets, resistors, transformers, rectifiers, etc.—Herbach & Rademan Inc., 1204 Arch St., Phila. 7, Pa.

Circle **391** on inquiry card.

Coils, Chokes, Transformers. New 32-page illustrated Catalog 54 describes maker's line of transformers, coils, chokes, condensers, wave traps, and filters.—J. W. Miller Co., 5917 S. Main St., Los Angeles, Calif.

Circle **392** on inquiry card.

Transformers. New 4-page illustrated Bulletin E100 describes maker's line of electrical, electronic, electromagnetic and electromechanical transformers.—Electro Engineering Works, 6021 College Ave., Oakland, Calif.

Circle **393** on inquiry card.

Low-pass Filters. New series of bulletins describes maker's "Series 400" low-pass RC filters, applications, and standard types.—White Instrument Labs., 203 Riverside Dr., Austin, Tex.

Circle **394** on inquiry card.

Delay Lines. New 4-page Bulletin Form 100 illustrates and gives general specifications for maker's solid ultrasonic delay lines for use in radar systems, impulse storage devices, digital computers, and electronic brains.—Andersen Laboratories, 39 Talcott Rd., West Hartford, Conn.

Circle **395** on inquiry card.

Molded Plastic Knobs. New 14-page illustrated Catalog 104 lists maker's line of plastic control knobs and handles.—Rogan Brothers, 8025 N. Monticello Ave., Skokie, Ill.

Circle **396** on inquiry card.

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For more information circle **148** on inquiry card.

NEW LITERATURE

Transformers. New catalog sheet, Bulletin 467, describes six transformers recently added to maker's line of stock components. Complete electrical and physical specifications are listed.—Chicago Standard Transformer Corp., Addison and Elston, Chicago, Ill.

Circle **397** on inquiry card.

Internal Insulators for Electron Tubes. New 4-page Bulletin 537 gives mechanical and electrical properties required in vacuum-tube insulators, and describes lava and synthetic ceramics in relation to these requirements.—American Lava Corp., Chattanooga 5, Tenn.

Circle **398** on inquiry card.

Motor Starters. New Bulletin 514-515 describes manufacturer's line of combination motor starters, with photos of various types and detail drawings of special features.—Federal Electric Products Co., 1429 Park St., Hartford, Conn.

Circle **399** on inquiry card.

Ceramic Insulators. New 4-page illustrated Bulletin presents maker's line of aluminum oxide insulators. 2-page insert sheet, Bulletin 226, describes "VX" super refractory type ceramic material, having great resistance to thermal shock.—Western Gold & Platinum Works, Ceramics Div., 589 Bryant St., San Francisco, Calif.

Circle **400** on inquiry card.

Full-wave Vacuum Rectifier. New 8-page illustrated Bulletin 5690-4-53 gives operating considerations and characteristics, rating charts, and features of maker's "Model 5690" full-wave vacuum rectifier tube.—Tube Dept., RCA, Harrison, N. J.

Circle **401** on inquiry card.

UHF Miniature Tube Sockets. New 2-page Bulletin AN-158 discusses advantages of using special UHF sockets for seven- and nine-inch miniature tubes in UHF television tuners and converters.—Tube Dept., RCA, Harrison, N. J.

Circle **402** on inquiry card.

FABRICATION, SHOP EQUIPMENT

Metal Fabrication. New 40-page illustrated Bulletin F3-652-NL-20M describes sheet-metal and plate fabrication service of maker, including plant facilities and types of equipment fabricated.—Kirk & Blum Mfg. Co., Cincinnati 9, Ohio.

Circle **403** on inquiry card.

Reciprocating Hand Machine. New 4-page illustrated bulletin describes applications of distributor's "Di-Profiler" in grinding, filing, scraping, honing, lapping, and polishing.—Engis Equipment Co., 431 S. Dearborn St., Chicago, Ill.

Circle **404** on inquiry card.

Micro Grinders. New 4-page bulletin describes and illustrates new English-made "Pultra" internal micro

grinder "Model 18A6a" equipped with hydro-mechanical in-feed.—Lorber Export, Import & Purchasing Co., 31 South St., New York, N. Y.

Circle **405** on inquiry card.

Leveling Screw. New 1-page Bulletin 110 lists features of maker's precision leveling screw designed to precisely align fixture bases, collimator mounts, and telescope mounts, and to lock them in position.—Opto Engineering Co., 3406 W. Washington Blvd., Los Angeles, Calif.

Circle **406** on inquiry card.

Small Parts Cabinets. New 6-page illustrated Bulletin 253 describes maker's line of drawers and cabinets for storage of small parts.—Precision Equipment Co., 3714 Milwaukee Ave., Chicago, Ill.

Circle **407** on inquiry card.

Index Table. New 8-page illustrated Bulletin (Vol. 3, No. 8) of "Denison Press" describes features and uses of maker's index table for rapid automatic work-feeding applications.—Denison Engineering Co., Columbus, Ohio.

Circle **408** on inquiry card.

Wheel Dressing Tools. New group of bulletins describe, illustrate, and price maker's dual wheel for finish grind and diamond lap. Includes accessories, procedures, dressing tools, and replacement parts.—Penn Scientific Products Co., 5941 Alma St., Phila., Pa.

Circle **409** on inquiry card.

Paste-Type Alloys. New 2-page List 1-1-51 gives prices of silver-brazing alloys, "Lo-melt" electric alloys, "Lo-melt" mechanical alloys, "Hi-power" special alloys, super jet torch and dry fuel tablets, and soldering and brazing kits.—Fusion Engineering, 4504 Superior Ave., Cleveland 3, Ohio.

Circle **410** on inquiry card.

Drafting Machines. New 20-page illustrated booklet describes maker's line of drafting machines, including gravity compensated, track type, civil engineering, and detail machines.—Charles Bruning Co., Inc., 4700 Monrose Ave., Chicago, Ill.

Circle **411** on inquiry card.

COMPONENTS

Precision Instrument Ball Bearings. New 28-page Catalog AIB describes classification, design and operating requirements of instrument bearings, examples of applications, operations in manufacture, and dimensional data for maker's instrument ball bearings. Request on letterhead.—New Departure Div., General Motors Corp., Bristol, Conn.

Circle **412** on inquiry card.

Springs. New 8-page illustrated August issue of "The Mainspring" describes metallurgy used in mechanical spring industry.—Associated Spring Corp., Bristol, Conn.

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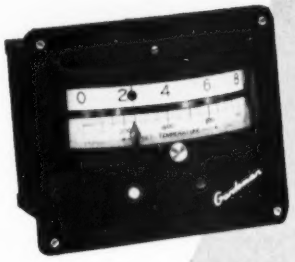

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NEW LITERATURE

Precision Optics, Patterns. New 8-page illustrated Bulletin RD describes facilities for research, development and manufacture of optics, reticles, circular and linear scales, resolution and test patterns, and other precision products.—W. & L. E. Gurley, Troy, N. Y.

Circle **414** on inquiry card.

MATERIALS

Powdered Brass Sintering. New 4-page illustrated Bulletin 8 describes uses of powdered brass sintering. Includes comparisons of various materials.—New Jersey Zinc Sales Co., Inc., 160 Front St., New York, N. Y.

Circle **415** on inquiry card.

Nickel, Alloys. New 32-page issue of "Inco" (Vol. 26, No. 2) describes practical applications for nickel and nickel alloys.—International Nickel Co., Inc., 67 Wall St., New York, N. Y.

Circle **416** on inquiry card.

Insulation Materials. New 12-page illustrated Catalog GF-54 describes maker's vulcanized fiber and plastic sheeting, tubing, rods and receptacles plus featuring technical data on tensile, flexural, shearing, impact, compressive, and dielectric strengths, water absorption rates, minimum densities, arc resistance, etc.—Continental-Diamond Fibre Co., Newark, Del.

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Reinforced Plastics. New 12-page illustrated Catalog 5.1.53 lists properties, sheet and rod data, chemical resistance, general properties, characteristics, comparisons with other laminates, relative properties of insulation, and typical applications of maker's reinforced plastics.—Dynakon Corp., 9623 Clinton Rd., Cleveland 9, Ohio.

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Rubberized Abrasives. New 8-page Catalog 53 presents treatise on rubberized abrasives in burring, smoothing and polishing operations, plus maker's line of abrasive wheels, points, blocks, sticks and cones for machine and manual application.—Aratex Mfg. Co., 81 Natoma St., San Francisco 5, Calif.

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Beryllium Copper. New 16-page illustrated booklet, "Applications Unlimited," describes typical uses for beryllium copper. Includes qualities of alloy.—Beryllium Corp., Reading, Pa.
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Silicone Rubber. New 8-page illustrated Bulletin AD-147 covers silicone rubber features and typical applications in oil seals, rings, insulation, diaphragms, gasketing, etc.—Garlock Packing Co., Palmyra, N. Y.
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MISCELLANEOUS

Flexible Metal Hose, Bellows. New 16-page illustrated Catalog CMH-132 covers specifications and features on maker's stainless-steel, brass, and bronze bellows and specifications and application data on convoluted and corrugated flexible metal hose and fittings.—Flexonics Corp., 1337 S. Third Ave., Maywood, Ill.
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Armored Tubing. New 4-page Bulletin E-248-53-10M describes features of maker's armored "Multitube," long length tubes twisted together to permit bending.—Crescent Insulated Wire & Cable Co., Trenton, N. J.
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Hydraulic Hose Assemblies. New 8-page Catalog 3-1952 covers maker's large line of hose assemblies for replacement and maintenance on hydraulic machines and mechanical equipment.—Carlyle Rubber Co., 64 Park Place, New York, N. Y.
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Solderforms. New 4-page Bulletin describes uses of maker's preshaped "Solderforms."—Kester Solder Co., 4201 Wrightwood Ave., Chicago, Ill.
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Industrial Glass Bearings. New 4-page Bulletin describes maker's industrial glass bearings for use where other types of bearings cannot handle application.—Farley M. Caldwell, 3201 Golden Ave., Cincinnati, Ohio.
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Instrument Production Facilities. New 8-page illustrated brochure describes manufacturing (machining and assembling) facilities for precision products. Includes mechanical and optical instruments, components, and details.—Q-O-S Corp., 39 W. 60 St., New York 23, N. Y.
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Consultants. New 4-page brochure describes instrumentation consulting service, including staff and industries where services can best be utilized.—Equipment & Controls Engineers Inc., 812 Noblestown Rd., Pittsburgh 5, Penna.
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Inspection Tool Castings. New 20-page catalog lists available shapes and sizes of stock rough castings for making industrial inspection tools—surface plates, angle plates, etc.—Myerstown Foundry and Machine Works, Myerstown, Pa.
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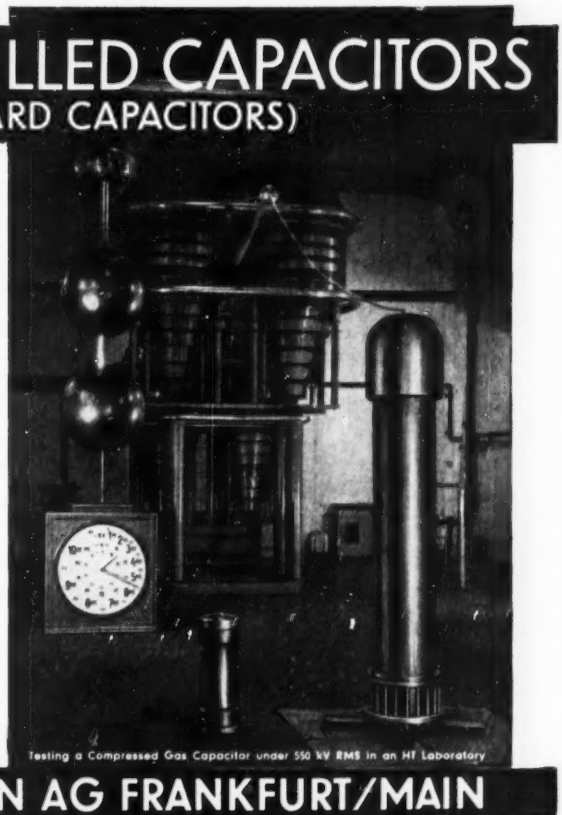

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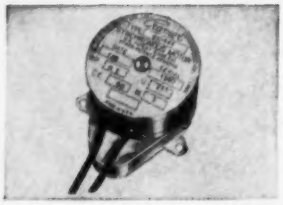

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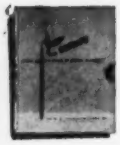

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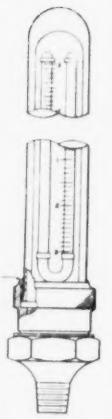

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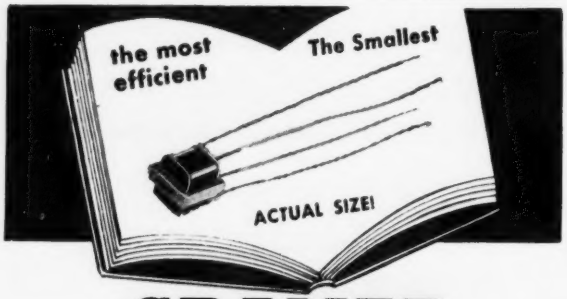

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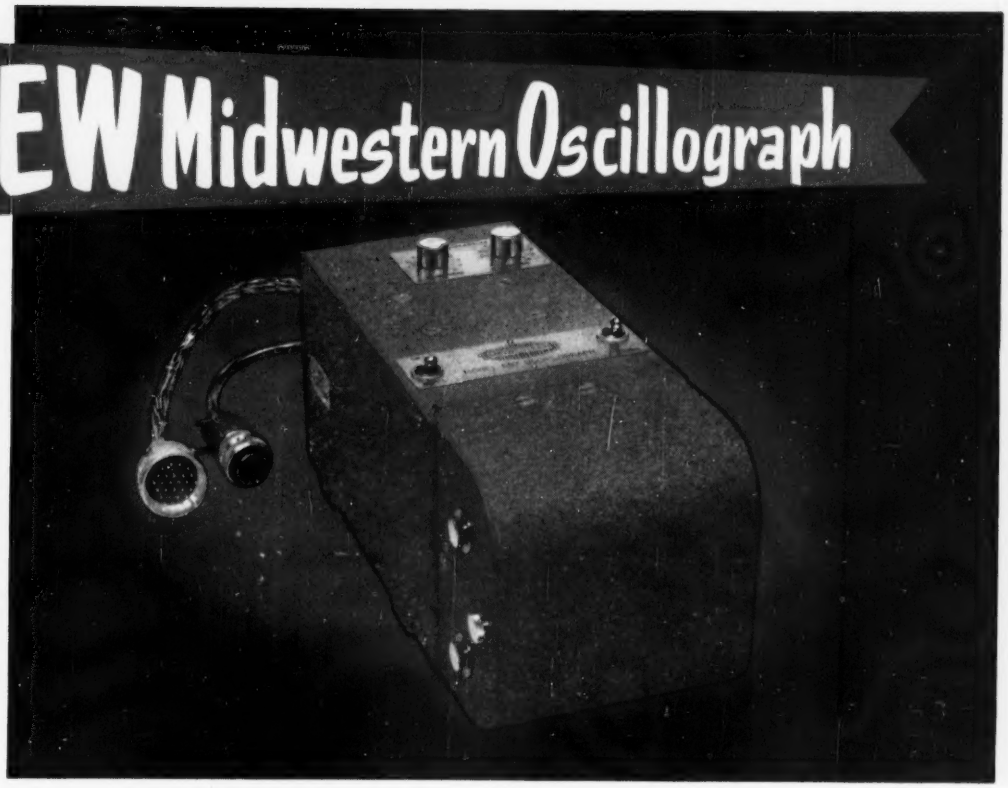

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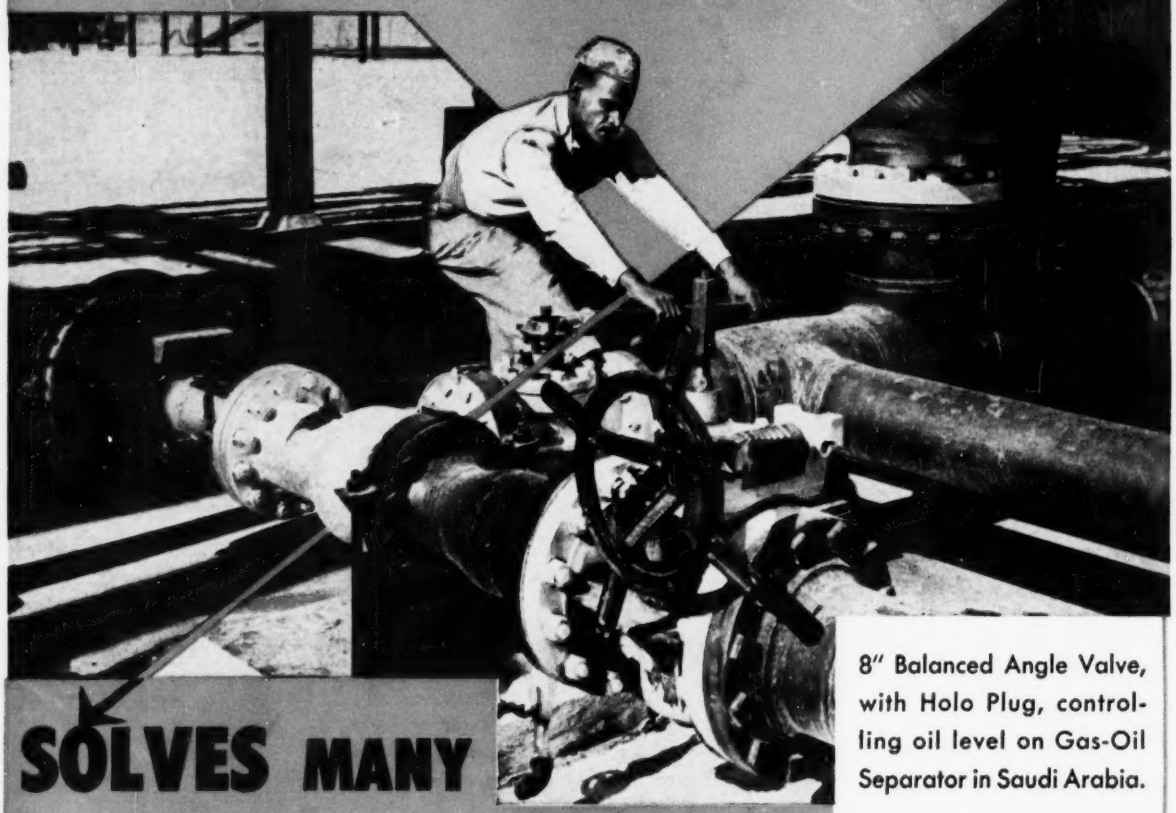

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